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# Scientific, Technical and Economic Committee for Fisheries (STECF)

# Evaluation of multi-annual plans for cod in Irish Sea, Kattegat, North Sea, and West of Scotland (STECF-11-07)

**Edited by John Simmonds and Sarah Kraak**

**This report was reviewed by the STECF during its 37th plenary meeting held from 11 to 25 July, 2011 in Copenhagen, Denmark.**

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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**Evaluation of multi-annual plans for cod in Irish Sea, Kattegat, North Sea, and West of Scotland (STECF-11-07)**

**This report was adopted by the STECF during its 37th plenary meeting held from 11 to 15 July, 2011 in Copenhagen, Denmark.**

**Request to the STECF**

STECF is requested to review the report of the **EWG-11-07** held from June 20 – 24, 2011 in Hamburg, Germany evaluate the findings and make any appropriate comments and recommendations.

## Introduction

A joint ICES / STECF meeting was held in Hamburg 20-24 June 2011, to prepare Impact Assessments for Southern hake, Nephrops and Angler fish and Baltic cod and an Evaluations of existing plans for Kattegat, North Sea, West of Scotland and Irish Sea cod. The meeting involved STECF, ICES scientists dealing with Economy and Biology and included Observers (Commission staff, Managers, Stakeholders). Three separate reports to the STECF were prepared by the EWG-11-07, one on the Impact Assessment of Southern hake, Nerphrops and Angler fish and another on the Impact Assessment for Baltic cod and the third on the Evaluation of Cod in Kattegat, North Sea, West of Scotland and Irish Sea. All reports were reviewed by the STECF during its 37th plenary meeting held from 11 to 15 July 2011 in Copenhagen, Denmark. The following observations, conclusions and recommendations represent the outcomes of that review for Kattegat, North Sea, West of Scotland and Irish Sea cod report.

This report which is the result of a cooperative work between ICES and STECF on management plan evaluations and the report ICES CM2011 ACOM/56 (ICES 1011) therefore is identical to the this STECF EWG11-07 report with the exception that a technical peer review of sections 13 and 14, which relate specifically to requests to ICES, have been added in the ICES version while overall STECF conclusions have been added here in the STECF version.

Annex 17 to this report contains an STECF report on Fishermans' survey carried out in cooperation with both NS and NWW RACs. The report was not available for the EWG meeting but was considered in full draft by STECF Plenary. The final draft is attached here as Annex 17.

**STECF observations**

STECF thanks the EWG-11-07 for its work with the Evaluation of the multi-annual management plan for fisheries on cod in Kattegat, North Sea, Irish Sea and West of

Scotland. STECF would also like to thank the NSRAC and NWWRAC for their contribution to the meeting. STECF draws the following conclusions and observations from the report.

### *Achievement of objectives:*

Given that the plan has only been in place for two and a half years (09, 10, first half of 2011), it is premature to conclude on the medium term impacts. It is not possible to predict how the plan will develop over the next few years as F and effort constraints intensify and the number of fleets operating under derogations increases. Nevertheless the STECF has drawn the main conclusions given below. With the data available, it was not always possible to assess whether any of aspect the plan has caused observed changes which are in line with plan objectives. Instead, we can, in some cases, comment on whether the desired objectives are being achieved, but we cannot say that any observed changes are or are not a result of the plans being implemented.

### *Exploitation rates and State of Stocks.*

North Sea: A full analytical assessment is available for this stock. Objectives of the plan have not been met in terms of F. F had declined and SSB had increased prior to introduction of plan. There have been continued but minor reductions in F and increases in SSB since the introduction of the plan. SSB has increased slowly over the last 6 years, but it is still below Blim.

Of the other stocks, there are assessments but these are only indicative of trends in mortality. For the West of Scotland and Irish Sea fishing mortality is very uncertain but total mortality remains very high and the best estimates of F indicate that it is well above target and not declining. In the Kattegat, there is a high degree of uncertainty in F. The uncertainties in mortality estimates arise from, among other factors, unallocated removals, and other (non-fishing) sources of mortality. For all three stocks biomass levels are estimated to be well below Blim. For Kattegat and Irish Sea recovery is failing and biomass has not increased. For the West of Scotland SSB has increased over the last 6 years.

Medium term simulations based on the current rate of change per year in F suggest that for North Sea, Irish Sea and West of Scotland cod stocks, following the current regime is unlikely to lead to F=Fmsy by 2015. Currently it is not possible to evaluate the likely success in terms of F by 2015 for Kattegat cod.

### *Additional Impacts of the multi-annual plan on the environment and the ecosystem*

Reductions in discards of commercial and non-commercial species, associated with Article 11 and Article 13 (technical measures), have been significant when these measures have been applied in some areas (e.g. North Sea).

Some technical measures have significantly reduced commercial by-catch (e.g. Nephrops fisheries with grids have become single-species fisheries).

Reported landings in most areas are in line with the landings limits in the plans, but in some areas catches are well in excess of TAC, leading to quota-driven discards of fish, e.g. in West of Scotland. This is identified as a problem using scientific data, RAC statements and a Fishermen's Survey conducted on a small sample of interviewed fishers. The Fishermen's Survey reports apparently 'conflicting' notions: (i) the feeling that cod avoidance is being carried out, and (ii) that discarding is being carried out because too much cod is being caught. This suggests that while cod avoidance is occurring it is currently insufficient.

Various fleets have opted to use more selective gear (Article 11 or Article 13) or to operate real time closures (Article 13) or to fish outside the distribution area of cod (Article 11).

Mortality of some other species such as haddock and whiting may have declined to levels consistent with CFP objective in some areas, and maybe partly due to the cod plan.

### *Influence of external factors (global change, ecosystems effects, or other fisheries)*

Increases in biomass may have been hindered by factors external to the fishery (e.g. seal predation on the West of Scotland).

### *Changes in fleet effort and capacity*

The starting baseline used in Article 12 of the plan is derived from the average of either 2004-2006 or 2005-2007 depending on MS choices. For the North Sea this means that allowed effort in the first year of the plan (Effort 2009 = 75% of the baseline) could be higher than 75% of effort in the preceding year (2008). Because the stipulated F reductions of 25% are relative to 2008, this resulted in effort reductions not being in line with F reductions. For the other stocks and years the percentages may have been different, but for the same reason the effort reductions were not in line with the F reductions.

Differences have occurred in the respective methodologies used to calculate effort from the reference years and methods used in the reported consumption of effort within the plan. This difference in methods has resulted in higher than intended deployed effort.

There has been a substantial decline in effort before the introduction of the current cod plan. Since the start of the plan, there has been a continued decline in effort although at a lower rate or in some cases a levelling out of effort. In all of the stock areas the total recorded effort by vessels using the gears for which cuts applied declined slightly, but, in 2009 and 2010, did not decline in line with the reductions required by the plans. Otter trawl gears contribute the highest effort amounts, with the relative importance of TR1 and TR2 otter trawl gears varying between areas. Beam trawl (BT2) effort is also very significant in the North Sea.

The extent of unregulated effort varies between areas. However, in all areas this is associated with minimal cod catches.

Effort associated with Article 11 is relatively low in all areas.

Effort associated with Article 13 ranges from 25% to 75% of total deployed effort and 46% to 71% of total cod catch among areas.

There have been positive contributions under Article 13c which appears to provide benefits towards achieving the cod plan targets. Article 13 allows a flexible, locally tailored response which should provide better governance with measures based directly on catches, landings and discards. Notable effects are: redistribution of effort away from higher abundance in Kattegat; unwanted bycatch and discard reductions in the northern North Sea by TR1 vessels; the use of more selective gears, and cod avoidance through real time closures. However, the verification aspects of Article 13 are too complex.

There have been reductions in fleet capacity; however, it was not possible from the evaluations available to indicate to what extent the plan was responsible for changes in fleet capacity. The decision by an owner (or owners) to remove a vessel from a given fishery depends on several factors and most of these factors are not influenced by the long term management plans, e.g. operating costs, offers of decommissioning grants, alternative fishing opportunities and factors relating to the personal circumstances of business owners. Therefore, in any event, the effects of a single species long term management plan are not likely to be key in determining any single decision about the removal of a vessel from the fishery subject to the plan.

The Fishermen's survey reports that the effort limits resulted in more time in port, changes in patterns of fishing activity, problems due to catch composition rules and discarding, and knock-on effects making it harder to keep a crew (see below).

### *Economic benefit/loss during the period of implementation*

It was not possible to conclude that the plan has had any impact on financial performance of the fleets involved compared to the situation likely to have prevailed in the absence of the plan. Analysis of changes in profitability at the level of fleet and vessel has not been possible due to inconsistency of cost data that were available from both DCR (in place prior to the cod plan) and DCF (which start coincided with the implementation of the cod plan). There are indications that revenue per vessel may have increased while total revenues of the whole fleet declined, but it is not possible to attribute these changes to the plan.

At a fleet and vessel level, reductions in effort may not necessarily result in the same proportion of reduction in revenue. Total Operating Costs at a fleet level have fallen in line with decline in total effort, but have increased at an individual vessel level due to increase in average effort per vessel.

A meta analysis such as this one, carried out on aggregated economic data can mask significant changes at an individual business level. Therefore, to understand the implications at an individual business level more detailed analysis would be required. But due to confidentiality issues, this type of study would have to be sponsored specifically by MS.

An Economic study based on DCF data and the Fishermen's Survey concluded that employment (number of people employed) has reduced.

### *Effects on the broader industry*

Although we cannot conclude that the plan has had any effect on vessel numbers or fleet capacity applied to the fishery, it may be worth noting that any reduction that have occurred will have had knock-on effects upstream and downstream in the economy, that is, for businesses supplying to vessels and for those purchasing from vessels.

### *Economic Indicators*

The economic indicators were only sufficient to describe changes over the period of analysis. It has not been possible to attribute any of those observed changes in the indicators to the multi-annual plan and hence they are not sufficient, on their own, to enable a robust evaluation.

The short run economic impacts of the multi-annual plan are not clear, in part because data at the required level of disaggregation is not available, and will depend on the balance of benefits resulting from increased cod TAC in the longer run and reductions in total (fleet level) costs resulting from reduced effort. The impact on long run economic sustainability will also depend on the stock effects of the plan (higher catch per unit of effort) which at this stage are unknown.

***Specific indicators or data that would be useful for a future evaluation of multi-annual plans***

- Fully documented effort allocation and deployment, landings and catch of cod for each vessel
- Economic data linked to vessels and specification of any derogation Article under which the vessel is operating.

***Any future revision should consider the following:***

- Several of the Articles in the plan are ambiguous or difficult to apply. As a general point, clear and unambiguous phrasing of the elements of regulations will make compliance more transparent and potentially more reliable.

## TAC and Effort control

- Fishing mortality can not be expected always to follow proportionally trends in fishing effort.
- Currently the combination of TACs (enforced as landings) and effort restrictions have been found to be inadequate in controlling cod removals, e.g. because enforced landings have resulted in discarding of over-quota catch. Reliance on these control instruments is a core weakness in the plan. Consideration should be given to use of cod catches (landings plus discards), as the main metric for allocating catch opportunities.
- The HCR in the plan is overly reliant on annual estimates of F which are either absent, inaccurate or imprecise. Consideration should be given to multiannual metrics for informing decisions. The lack of analytical assessments in WoS, Irish Sea and Kattegat preclude the application of the HCR. Therefore different metrics are needed for the application of the HCR.
- Short term forecasts for North Sea show bias in estimating SSB and F; specifically, SSB is overestimated and F is underestimated; by comparison removals estimates were less biased. It is recommended that the current practice of assuming the plan is working for the intermediate year, should cease; currently it is preferable to assume Fstatus quo in the intermediate year. In the longer term alternative methods of setting TACs should be tested to see if they are more robust for predicting F for specified removals.
- The cod LTMPs were designed without consideration of the fishing opportunities for other species. Mixed fisheries simulations give an indication of the potential for disparity between fishing opportunities and thus implementation error in North Sea cod advice. Actual F may be higher than stipulated in the LTMP if there is continued fishing for other species with higher TACs as well as of the potential over-catch or underutilization of other TACs. The plan would benefit from linking to plans for Nephrops, haddock, whiting, saithe, sole and plaice in the North Sea.

## Exemptions under the current plan

- Exemptions through Article 11 require low cod catches. These exemptions should only be approved when the fishing activity is deployed outside the distribution area of cod, or if deployed within the cod distribution area, when the used fishing gear is designed and confirmed to minimize cod catches.
- Basing monitoring on percentage of cod in the total catch (as in Articles 11 and 13.2b) is flawed, because even when percentages of cod in the catch are low, these catches can still contribute significantly to overall cod mortality if overall catch or effort is high or when abundance is low. Cod by-catch ceilings expressed as percentages of total catch also have a

perverse incentive to maintain or increase catches of other species. STECF identified bycatch ceilings as a flaw in the design of the plan. A system based on proportion of total expected cod outtake from the whole fishery would be more appropriate, and likely no more difficult to monitor.

Verification of Article 13 exemption, based on expected effects on F, cannot be carried out in most cases. By specifying Article 13 exemption on the basis of total catch (landings and discards) of cod it is expected to be easier for fishermen to understand, implement, and verify their compliance with the conditions of the derogation.

**STECF conclusions**

Overall STECF concludes that the plan is not delivering reduced F and additionally in many areas does not have stakeholders' support. A plan which stakeholders support is more likely to succeed because the stakeholders' actions are needed to contribute to its success. Support of the plan also should also, in theory, lead to their acceptance of responsibility to fulfil their obligations.

STECF agrees with the findings of the STECF EWG report on the Evaluation of multi-annual plans for cod in Kattegat, North Sea, Irish Sea and West of Scotland (EWG 11-07b)

**STECF recommendations**

For observers, it would be desirable if the STECF secretariat could notify the DG MARE focal person for the RACs to issue a timely reminder to the RACs of those STECF meetings open to observers, to ensure that all appropriate people are invited to register in an acceptable time frame. The DG MARE focal persons for specific EWGs should also inform the secretariat in due time if Member States representatives should be invited to a meeting.

In preparation for the Impact Assessment of a revised plan, a scoping meeting is required. In order for scientific advice to be given, Commission and MS need to indicate in that meeting a range of aspects

- The regulatory measures they might be prepared to implement, and specifically those they are not willing to consider, to focus available expertise in the most productive areas.
- Specific objectives with timescales and if there are multiple objectives some idea of the tradeoffs.
- If catch quotas are to considered for some fleets, those with expertise in compliance should be requested to attend to discuss compliance for catch quotas, likely errors and uncertainties.

# REPORT TO THE STECF/ICES

# EXPERT WORKING GROUP EVALUATION OF MULTI-ANNUAL PLANS FOR COD IN IRISH SEA, KATTEGAT, NORTH SEA, AND WEST OF SCOTLAND
# STECF-11-07 / WKROUNDMP2011

## Hamburg, Germany. 20-24 June 2011

# 1. Executive summary

A joint ICES / STECF meeting was held in Hamburg 20-24 June 2011, to prepare an Evaluation of multi-annual plans for cod in Kattegat, North Sea, Irish Sea and West of Scotland. The meeting involved STECF, ICES scientists dealing with Economy and Biology and included Observers (Commission staff, Managers, Stakeholders). Three separate reports to the STECF were prepared by the EWG-11-07, one on the Impact Assessment of Southern hake, Nephrops and Angler fish (STECF-11-06) and another on the Impact Assessments for Baltic cod (STEC 11-005) and this third on the Evaluation of Cod in Kattegat, North Sea, West of Scotland and Irish Sea (STEC 11-07).

Given that the plan is only into place for 3 years, it is premature to conclude on the medium term impact, but STECF has drawn the following main conclusions

***Objectives*** have not been met in terms of F. From a biological perspective all the cod stocks covered by the plan are currently likely to have an SSB below Blim. However, for North Sea and West of Scotland cod SSB has increased in recent years. Fishing mortality has not declined as envisaged by the plan. While mortality is considered to be well above the target objectives in line with the current plan, the exact level of F is unknown due to uncertainties in mortality estimates arising from *inter alia* unallocated removals, catches in excess of TAC and other sources of mortality. Medium term simulations based on the current rate of change per year in F suggest that for North Sea, Irish Sea and West of Scotland cod stocks it is unlikely that following the current regime F will reduce sufficiently to reach F=Fmsy by 2015. Currently it is not possible to evaluate the likely success in terms of F by 2015 for Kattegat cod.

***Impacts of the multi-annual plan on the environment and the ecosystem:*** Reductions on discards, on commercial and non-commercial species, associated with Article 11 and Article 13 (technical measures) have been significant when used in some areas (e.g. North Sea).Some technical measures have significantly reduced commercial by-catch. Reported landings in most areas are in line with the plan, but due to high discards in some areas, catches are well in excess of TAC e.g. West of Scotland. Positive responses in biomass may have been hindered by external factors (e.g. seal predation on the West of Scotland).

***Trends in fleet capacity:*** There has been a substantial decline in effort, although much of this occurred before introduction of the current cod plan. Otter trawl gears contribute the highest effort amounts, with the importance of TR1 and TR2 gears varying between areas. Beam trawl (BT2) effort is also very significant in the North Sea The extent of unregulated effort varies between areas. However, this is associated with minimal cod catches; effort associated with Article 11 is relatively low in all areas, effort associated with Article 13 ranges from 25% to 75% between areas.

***Efficiency:*** At a fleet and vessel level, reductions in effort may not necessarily result in commensurate reduction in revenue as business will be incentivized to maximize revenue from available effort. Costs at a fleet level have fallen in line with effort, but have increased at an individual vessel level. Meta analysis can mask significant changes at an individual business level. Therefore, to understand the implications at an individual business level more detailed analysis would be required. According to a sociological study, based on a small sample of interviewed fishers, employment has gone down. Additionally results from economic studies show that employment has fallen.

There have been positive contributions under Article 13c which appears to provide benefits towards achieving the cod plan targets. Article 13 allows a flexible, locally tailored response which should provide better governance with measures based directly on landings and discards. Notable effects are: redistribution of effort away from higher abundance in Kattagat; discard reductions in the northern

North Sea by TR1 vessels; the use of more selective gears, and cod avoidance through real time closures. However, the verification aspects of Article 13 are too complex.

***The Workshop identified a range of aspects to be considered with any revision including inter alia:-*** Substitute alternative metrics for TACs. Consideration of multiannual metrics for informing decisions. Account for mixed fisheries as potential implementation error. Fishing mortality should not be expected to follow trends in fishing effort. Exemptions through Article 11 should only be approved when the fishing activity is deployed outside the distribution area of cod, or if deployed within the cod distribution area, when the used fishing gear is designed and confirmed to minimize cod catches. Cod catches lower than a certain % (as in Articles 11 and 13.2b) can still contribute significantly to overall cod mortality if overall catch or effort is high or when abundance is low. This is a fundamental flaw in the design of the plan. A system based on proportion of total expected cod outtake from the whole fishery would be more appropriate. Basing monitoring on percentage composition (as in Articles 11 and 13) provides a disincentive to improve selectivity for other species as reducing overall catch can increase the percentage of cod even if cod catches are constant.

## 2. CONCLUSIONS OF THE WORKING GROUP

Based on the above analyses the Workshop came to the following conclusions and observations

***Effectiveness:*** Given that the plan is only into place for 3 years, it is premature to conclude on the medium term impact, but STECF has drawn the following main conclusions

- A full analytical assessment is available only for North Sea cod. Objectives have not been met in terms of F. F has declined and SSB has increased prior to introduction of plan. There have been continued but minor reductions in F and increases in SSB since the introduction of the plan. Progress towards target is hindered due to TAC and effort regime failing to constrain removals.

- Of the other stocks, there are assessments but these are only indicative of trends in F and biomass. For the West of Scotland and Irish Sea fishing mortality is very uncertain but total mortality remains very high. In the Kattegat, there is a high degree of uncertainty in F. Biomass levels are estimated to be well below Blim

- Objectives in terms of F reductions do not appear to have been met in WoS, Kattegat and the Irish Sea, but, while mortality is considered to be well above the target objectives in line with the current plan, the exact level of F is unknown due to uncertainties in mortality estimates arising from *inter alia* unallocated removals, catches in excess of TAC and other sources of mortality. ,

- Medium term simulations based on the current rate of change per year in F suggest that for North Sea, Irish Sea and West of Scotland cod stocks it is unlikely that following the current regime F will reduce sufficiently to reach F=Fmsy by 2015. Currently it is not possible to evaluate the likely success in terms of F by 2015 for Kattegat cod.

### *Impacts of the multi-annual plan on the environment and the ecosystem*

- Reductions on discards, on commercial and non-commercial species, associated with Article 11 and Article 13 (technical measures) have been significant when used in some areas (e.g. North Sea).

- Some technical measures have significantly reduced commercial by-catch (e.g. Nephrops fisheries with grids have become single-species fisheries).

- Reported landings in most areas are in line with the plan, but due to high discards in some areas, catches are well in excess of TAC e.g. West of Scotland

- Effort displacement may have had a negative impact.

### *Side effects resulting from the plan*

- Various fleets have committed themselves to use more selective gear (Article 11 or Article 13) or to real time closures (Article 13) or to fish outside the distribution area of cod (Article 11).

### *Influence of external factors (global change, ecosystems effects, or other fisheries)*

- Positive responses in biomass may have been hindered by external factors (e.g. seal predation on the West of Scotland).

### Utility *trends in fleet capacity (kW or GT)*

- There has been a substantial decline in effort, although much of this occurred before introduction of the current cod plan, and continued decline at a lower rate or in some cases leveling out.

- Otter trawl gears contribute the highest effort amounts, with the importance of TR1 and TR2 gears varying between areas. Beam trawl (BT2) effort is also very significant in the North Sea

- The extent of unregulated effort varies between areas. However, this is associated with minimal cod catches

- Effort associated with Article 11 is relatively low in all areas,

- Effort associated with Article 13 ranges from 25% to 75% between areas

### *Capacity:*

- Currently we are unable to estimate the appropriate capacity for these fleets due to the complexity of the species mixtures and the shortage of economic data.

- It was not possible from the evaluations available to indicate to what extent the plan alone was responsible for changes in fleet capacity (fuel prices and fish prices have recently been volatile).

### Efficiency (cost-effectiveness)

#### *The costs of this plan in terms employment, gross revenue of the fleet*

- At a fleet and vessel level, reductions in effort may not necessarily result in commensurate reduction in revenue as business will be incentivized to maximize revenue from available effort.

- Costs at a fleet level have fallen in line with effort, but have increased at an individual vessel level.

- Meta analysis can mask significant changes at an individual business level. Therefore, to understand the implications at an individual business level more detailed analysis would be required.

- According to a sociological study, based on a small sample of interviewed fishers, employment has gone down. Additionally results from economic studies show that employment has fallen.

***Effects on the broader industry***

- Implicit in the reduction in capacity, there are likely to have been negative consequences for the broader industry, although there are no specific documented cases which can be attributed to the Plan.

***Economic benefit/loss during the period of implementation***

- Analysis of changes in profitability at the level of fleet and vessel has not been possible due to concerns over the quality of the cost data. There are indications that revenue per vessel may have increased while falling at the fleet level, but it is not possible to attribute these changes to the Cod Plan.

***Indicators***

- The economic indicators were only sufficient to describe changes over the period of analysis. It has not been possible to attribute any of those observed changes in the indicators to the multi-annual plan and hence they are not sufficient, on their own, to enable a robust evaluation.

***Sustainability (relative to the initial impact assessment)***

- From a biological perspective all the cod stocks covered by the plan are currently likely to have an SSB below Blim. However, for North Sea and West of Scotland cod SSB has increased in recent years.

- Fishing mortality has not declined as envisaged by the plan

- The long run (i.e. taking account of stock effects) economic sustainability of the plan cannot be judged at this stage.

## Conclusions

Workshop draws the following global judgement on the plan

***With regards to the utility and sustainability of the multi-annual plan and its contribution to the objectives of the Common Fisheries Policy.***

- The plan has not controlled fishing mortality as envisaged.

- Mortality of some other species such as haddock and whiting may have declined to levels consistent with CFP objective in some areas, and maybe partly due to cod plan.

- The short run economic impacts of the multi-annual plan are not clear and will depend on the balance of benefits resulting from increased cod TAC and costs resulting from reduced effort.

The impact on long run economic sustainability will also depend on the stock effects of the plan which at this stage are unknown.

***Success in achieving its stated objectives***

- The plan has not achieved its stated objectives.

- In all of the stock areas the total recorded effort by the gears for which cuts applied decline slightly, but did not decline, in 2009 and 2010, in line with the reductions according to the plan.

- There have been positive contributions under Article 13c which appears to provide benefits towards achieving the cod plan targets. Article 13 allows a flexible, locally tailored response which should provide better governance with measures based directly on landings and discards. Notable effects are: redistribution of effort away from higher abundance in Kattagat; discard reductions in the northern North Sea by TR1 vessels; the use of more selective gears, and cod avoidance through real time closures. However, the verification aspects of Article 13 are too complex.

***Specific indicators that would be useful for a future evaluation of this multi-annual plan***

- Fully documented catch of cod by vessel

***Additional data that should be collected in the future to help in evaluating the multi-annual plan***

- Economic data linked to vessels operating specifically under the cod plan by Article along with documented catch of cod by vessel

***Other plans this plan should be linked to***

- The plan would benefit from linking to plans for Nephrops and haddock, whiting, saithe sole and plaice in the North Sea.

***Any future revision should consider the following:***

- Substitute alternative metrics for TAC (as Total Allowed Landings) or the current effort regime to regulate catches. These have been unable to adequately control cod removals. Reliance on these control instruments is a core weakness in the plan.

- The HCR in the plan is overly reliant on annual estimates of F which are either absent, inaccurate or imprecise. Consideration should be given to multiannual metrics for informing decisions.

- The lack of analytical assessments in WoS, Irish Sea and Kattegat preclude the application of the HCR. Therefore different metrics are needed for the application of the HCR.

- Short term forecast has been available for North Sea cod and has not been available for other cod stocks.

- Short term forecasts show bias in estimating SSB and F; specifically, SSB is overestimated and F is underestimated; by comparison removals were estimated less biased

- Single-stock LTMPs were designed without consideration of the fishing opportunities for other species. Mixed fisheries simulations give an indication of the potential implementation error in North Sea cod advice, with actual F being higher than stipulated in the LTMP if there is continued fishing for other species with higher TACs as well as of the potential overcatch or underutilization of TACs.

- It is concluded that we should not necessarily expect fishing mortality to follow trends in fishing effort.

- Exemptions through Article 11 require low cod catches. These exemptions should only be approved when the fishing activity is deployed outside the distribution area of cod, or if deployed within the cod distribution area, when the used fishing gear is designed and confirmed to minimize cod catches.

- Cod catches lower than a certain % (as in Articles 11 and 13.2b) can still contribute significantly to overall cod mortality if overall catch or effort is high or when abundance is low. This is a fundamental flaw in the design of the plan. A system based on proportion of total expected cod outtake from the whole fishery would be more appropriate.

- Basing monitoring on percentage composition (as in Articles 11 and 13) provides a disincentive to improve selectivity for other species as reducing overall catch can increase the percentage of cod even if cod catches are constant.

- The starting baseline used in Article 12 of the plan is derived from the average of either 2004-2006 or 2005-2007 depending on MS choices. For the North Sea this means that allowed effort in the first year of the plan (Effort 2009 = 75% of the baseline) could be higher than 75% of effort in the preceding year (2008). Because the stipulated F reductions of 25% are relative to 2008, this resulted in effort reductions not being in line with F reductions. For the other stocks the percentages may have been different, but for the same reason the effort reductions were not in line with the F reductions.

- Differences have occurred in the respective methodologies used to calculate effort from the reference years and those in the reported consumption of effort within the plan. This will have resulted in higher then intended effort.

- Clear and unambiguous phrasing of the elements of regulations will make compliance more transparent and potentially more reliable.

## 3. RECOMMENDATIONS OF THE WORKING GROUP

For Observers STECF/ICES and Commission should find a way to define exactly who and facilitate contact with all those who need to be notified of STECF meetings in the future.

In preparation for the Impact Assessment of a revised plan, a scoping meeting will be required. In order for scientific advice to be given, Commission and MS need to indicate in that meeting a range of aspects

- The regulatory measures they might be prepared to implement, and specifically those they are not willing to consider, to focus available expertise in the most productive areas.
- Specific objectives with timescales and if there are multiple objectives some idea of the tradeoffs.
- If catch quotas are to considered for some fleets, those with expertise in compliance should be requested to attend to discuss compliance for catch quotas, likely errors and uncertainties.

## 4. INTRODUCTION

EWG 11-07 met in Hamburg 20-24 June 2011. The WG was organised with STECF members, invited experts, observers from Baltic NS, NWW and SWW RACs, and managers from some MSs.

### 4.1. Terms of Reference for EWG-11-07

The Workshop on Management plans Part 2 (ICES - WKMPROUNDMP2011 STECF – EWG 11-07), chaired by John Simmonds, Italy, will meet at VTI, Hamburg, Germany 20–24 June 2011 to:

1. provide Impact Assessment reports (2 reports) for
   - Baltic Cod
   - Southern hake, anglerfish and *Nephrops*
2. provide a combined Evaluation report on cod plans for the following areas:
   - Kattegat
   - North Sea
   - West of Scotland
   - Irish Sea
3. provide a Clarification on NS whiting advice

WKMPROUND2001/EWG 11-07 will provide a complete draft report by 1 July to the attention of the STECF and ACOM and a final draft by 6 July.

Procedures and work will follow the work plan specified in the ICES-STECF report WKMPROUND2001 EWG11-01, March 2011 for cod plans and the ad hoc meeting 29-30 March, Brussels for Southern hake anglerfish and *Nephrops*.

### 4.2. Agenda

The approach to the meeting was to hold discussions on each TOR separately in order to allow Observers and Commission Staff to organise their attendance efficiently.

Monday 20 June Open the meeting 1400
Report requirements, Section responsibilities and agree Section structure, admin details.
Discussion in subgroups to provide detailed timed agendas for Tuesday and Wednesday
Tuesday 0900 - 1800
Presentations on Southern hake, angler, *Nephrops*, Baltic cod
Discussion for conclusions
Wednesday 0900 - 1800
Presentations on Kat, NS, IS and WoS cod and NS whiting.
Discussion for conclusions
Thursday
Draft text and first drafts of conclusions
Friday
Draft text and final drafts of conclusions
Friday 1500 Meeting close

The agenda provided an opportunity for the NSRAC and NWWRAC covering the fisheries dealt with under the cod plans, to provide a statement relating their experience with the plan. These statements are included as annexes to the report (Annex 2 NSRAC and Annex 3 NWWRAC); these do not formally form part of the main body of the report as they are not independent but express an opinion of stakeholders. Nevertheless, the STECF group would like to thank the RACs for providing these and where it is considered relevant they are cited by STECF independent experts in the body of the report.

### 4.3. Reports

The TOR requires separate reports of the meeting for each task. This report deals specifically with Evaluation of multi-annual plans for cod in Kattegat, North Sea, Irish Sea, and West of Scotland. Three other reports are prepared: (i) an overall ICES-STECF report containing details of the whiting response, and separate reports (ii) for Southern hake, angler and Nephrops, and (iii) for the Impact Assessment on multi-annual plans for Baltic cod.

### 4.4. Participants

The full list of participants at EWG-11-07 is presented in section 14.

## 5. OVERVIEW OF COD PLANS FOR IRISH SEA, KATTEGAT, NORTH SEA AND WEST OF SCOTLAND

### 5.1. Problem statement

The Regulation 1342/2008 establishing a long-term plan for cod stocks and fisheries exploiting those stocks entered into force on the 1st January 2009. The Regulation establishes a plan for four cod stocks in the geographical areas (i) Kattegat, (ii) the North Sea including the Skagerrak and the eastern Channel, (iii) the West of Scotland and (iv) the Irish Sea. The plan includes an obligation for the Commission, on the basis of advice from STECF and after consultation of the RACs, to evaluate the impact of the management measures on the cod stock and the fisheries on those stocks in the third year of its application, and then each third successive year.

### 5.2. A review of the historic implementation of the multi-annual plan

Prior to 2004 emergency recovery measures had been implemented on an individual basis.

Recovery plans for cod were first implemented in the Irish Sea in 2000. Two emergency closed areas were established (EC.304/2000) in which fishing for cod was prohibited between 14th February and 30th April. Subsequent regulations (EC.2549/2000 and EC.1456/2000) established additional technical measures for the protection of juveniles. The closed area in the western Irish Sea was continued in subsequent years. A derogation to fish inside this closed area has applied in all years for vessels fishing for Nephrops.

Emergency measures were enacted in 2001 for the West of Scotland consisting of area closures in the Clyde from 6th March to 30th April. An additional closed area, known as the windsock (EC.2287/2003) was implemented in 2004 and has remained in force since. In addition there have been unilateral closures, by Ireland, of a traditional fishery for juvenile cod off Greencastle. This voluntary closure was in force for variable periods of time between 2003 and 2006.

In the North Sea in 2001, a cod closure area was introduced as part of the stock recovery programme (EC.259/2001). The area was closed to any fishing activity during this period, with the exception of purse seining and trawling for sandeels and pelagics. This temporary closed area was designed to cover the main spawning period of cod in the North Sea, and was in force throughout the period 14 February to 30 April 2001. In addition, TAC reductions in 2001 and 2002 were aimed at reducing fishing mortality by more than 50 per cent. Fishing effort restrictions were also implemented from 1 February 2003 for vessels of overall length greater than or equal to 10m. This restricted the number of days per month different types of vessels (i.e., using different gear types) could employ in different parts of ICES areas IV and IIIa (EC.671/2003, amending EC.2341/2002).

Council regulation EC.423/2004 established a raft of measures for the recovery of cod stocks. These included multi-annual process for the selection of TACs, restriction of fishing effort, technical measures, control and enforcement and accompanying structural and market measures.

In November 2008 COUNCIL REGULATION (EC) No 1342/2008 established the current plan

## 5.3. Design Issues

The following aspects detailed by Article number from the cod plan (COUNCIL REGULATION (EC) No 1342/2008) have been identified and form the basis for examining design issues:

### *5.3.1. Interpretation issues, related to Articles 7 and 8*

When performing the simulations for the Impact Assessment for the HCR components of Council Regulation (EC) 1342/2008 (Articles 7 and 8), difficulties were encountered with coding the HCR elements. Several assumptions were required. The following details the assumptions that were made when performing the impact assessment (MSE), and any differences that subsequently occurred in implementation when carrying out annual short term forecasts (STF).

Interpretation issues **Article 7**

7(1a) Method for calculating expected quantity of discards for the TAC year was not defined

Solution MSE: average discard ratio at age for final 3 years of data

Interpretation issues **Article 8**

**TAC calculations**

8(1) Expected quantity of discards for TAC year (refer to 7(1a) above)

Solution MSE: average discard ratio at age for final 3 years of data (see above)

STF: discard ratio for final year of catch data

8(1) Calculating TAC [refer to 7(1a)]

Solution MSE: remove unallocated mortality prior to calculating TAC

STF: landings and discard components scaled up to account for unallocated mortality

8(3) cuts in F relative to 2008

Solution: MSE and STF: assume that F2008 is re-estimated by the assessment method, and not fixed to the value estimated by the assessment the first time the plan was implemented.

It is suggested that regulations contain a technical annex that clearly define how quantities will be calculated. If needed this annex could be updated by agreement without changing the regulation.

### *5.3.2. Effort calculations and issues for stocks without assessments*

For both MSE and STF: there is nothing in Article 8 (equivalent to Article 7(4)) to say what should be assumed about the effect of effort cuts in the intermediate year. This is because for the HCR, Article 7 needs an estimate of SSB at the beginning of the TAC year (and therefore needs assumptions about what happens in terms of F), while article 8 only needs SSB at the beginning of the intermediate year. However, in order to calculate the TAC, one still needs to project the population forward through the intermediate year, and therefore one needs to know what happened in terms of F during the intermediate year. In practice the regulation has been assumed to work; this may be an unsatisfactory solution, see Section 6.7.

A particular issue in the implementation of the LTMP for the cod stocks is the absence of accepted assessment for a number of these. LTMP have been designed around the classical concept of defining a target F and a yearly HCR aiming at moving from current F levels towards this target F.

However, this can only be achieved in the case where there is an accepted analytical assessment, which is not the case for three out of the four cod stocks concerned. Furthermore, even in the case of stocks with accepted assessment, uncertainty is often largest for the estimate of the current year (at least for VPA-based assessment), and therefore a HCR rule relying too heavily on the final assessment year may become unstable.

As a consequence, it has been difficult to formulate TAC advice based on the LTMP rules, and to conduct scientific evaluation of e.g. cod avoidance plans with regards to expected reductions in fishing mortality, since this could not be measured.

Obviously, a LTMP should be designed from the beginning to be easily implemented, i.e. management measures should be tailored to the possibility to apply and monitor them. The basis should be the level of scientific knowledge used for advice at the time the plan is initiated, as it is illusory to expect that the quality of stock assessment will necessarily improve after the implementation of the LTMP. Although implementing a LTMP may directly or indirectly contribute to better data through increased control and monitoring, this may not be a sufficient condition for solving the recurrent issues in the assessment of cod stocks. Indeed successfully achieving a change in the fishery is likely to make an assessment, which relies on smoothing assumptions, give poorer results initially. In either case, it is unlikely that this improvement of stock assessment would occur in the first years of implementation.

### *5.3.3. Interpretation issues of Article 11.*

Article 11(2) of the cod plan makes provision for The Council, acting on a Commission proposal and on the basis of the information provided by Member States and the advice of STECF, to exclude certain groups of vessels from the effort regime, provided certain conditions are met. STECF are then requested by the Commission to evaluate each individual request to assess whether sufficient data had been presented so as to determine whether the conditions laid out were being fulfilled. A detailed summary of the use of Article 11 is included in Annex 1. Since the introduction of the regulation STECF has evaluated 34 proposals from France, Spain, UK (Scotland, Northern Ireland, Isle of Mann, England), Sweden, Ireland, Poland and Germany. Of them only 6 submissions, from UK (Scotland), Sweden, Ireland, France, Poland and Spain, have been approved. The French exemption was revoked as it was considered that the application no longer constituted an administrative burden (EC regulation 57/2011). In the first evaluations, conducted by written procedure (STECF 2009), STECF was requested to evaluate a number of exemption cases.

At the start of the evaluation process undertaken by STECF, the information presented by the individual member states varied considerably, and this remained an issue for subsequent applications. The variability in the information presented was probably due to a lack of data specification for the data requirements. The implementation regulation that lays down the detailed rules for the application of 1342/2009 only came into effect in 2010 (EC regulation 237/2010). This legislative vacuum resulted in STECF having to interpret article 11.2, develop evaluation criteria and provide suggested data requirements. This led to an adaptive process over several plenary meetings whereby the data and criteria STECF considered necessary to undertake evolved over time based on the data provided by member states. This, in some cases, led to further requests for additional material to be supplied by member states before a thorough evaluation could be made.

STECF (2009) noted that catches of cod <1.5% at a fleet or individual vessel level can be achieved through three possible mechanisms: (i) Technical decoupling through the application of modifications to the fishing gear that inhibits or reduces cod catches; (ii) Spatial and/or seasonal decoupling, where the fishing activity is conducted in areas, at depths, and/or in seasons that are historically not associated with cod distribution and catches; and (iii) Decoupling through cod stock depletion, where historically, cod catches in the area where the fleet/métier operates are likely to have exceeded 1.5% if the cod biomass was at a higher level. While in many cases STECF concluded that the submission lacked primary data – e.g. landings data were presented as opposed to catch, or it was not possible to link observer trips to métiers etc. – STECF also commented on whether it was possible to assess if the cod catch levels were due to spatial decoupling or stock depletion, and if there was insufficient evidence STECF was unable to advise on such cases. Given the variability in the data submissions and the need to disentangle spatial and depletion decoupling, STECF (2009) recommended a range of data fields that could be used as standardised and stable criteria for evaluation purposes. These became the basis for a standardised content and format for requests for exclusion in the implementation regulation (Annex I of EC regulation 237/2010). However, the specifications for data requirements given in this regulation are still ambiguous and open to multiple interpretation and have actually been interpreted differently by MSs. Nevertheless, by the time this regulation came into force, STECF had already evaluated 31 separate fleets. In many cases, these were repeat evaluations of requests that had been re-submitted by Member States but with additional data. Where it was not possible to disentangle between depletion and spatial decoupling, STECF adopted the precautionary approach, noting where depletion decoupling was likely. Seeking clarification, STECF (2009) notes that "The Commission clarified that STECF is requested to judge whether, based on the scientific evidence presented, it can be ascertained that real decoupling between the fishing activity and the impact on cod stocks exists". However, during the Winter Plenary (2009), STECF was asked again to reassess the submissions presented during the previous plenary meeting. The background information from the commission noted the following:

"The Commission's approach to vessel exclusions under the cod plan (Article 11(2) cod plan) has taken into account the STECF's concept of technical or biological decoupling, but would in addition favour vessel exclusions based on vessel group characteristics that result in current catch rates of cod below 1,5% in the vessel group (on average), provided that (i) the effort reduction coming along with such an exclusion would be permanent; (ii) the vessel activity would be automatically counted against the reduced effort ceilings when either a vessel no longer meets the group characteristics or the group catches exceed more than 1,5% cod (averaged over the year), and (iii) the Member State has put in place a monitoring system that will provide representative catch data enabling the Commission to assess whether the fulfilment of the exclusion criterion at the group level continues to be met."

The terms of reference therefore simply asked whether the cod catches were in fact below 1.5% with no reference to detailed elements requested previously. STECF (2009) reiterated its previous concerns relating to the problems of being unable to disentangle the likelihood of spatial from depletion decoupling in any given case and noted "STECF do not consider the third criteria as a condition for effort exemptions. Providing effort exceptions to groups of vessels that meet the third criterion has the potential to negate any attempts to reduce cod mortality and could inhibit stock rebuilding." The inclusion of point (i) in the Commission's statement above was to provide a strong incentive to ensure that the group of vessels seeking exemption were associated with areas outside the historic distribution of cod, as if stocks recovered and cod catches went above 1.5% in the future then effort would have to be taken from a reduced effort allocation. However, following the December council in 2009, point (i) above was not introduced.

The industry perception of article 11 is that it is difficult to gain exemption and that it has proved impossible to gain exemption for fleets that catch few cod because of problems of providing sufficient data (see NSRAC submission Annex 2). It is noted in the submission by the NWWRAC (Annex 3) that there is lack of transparency over the criteria to deliver the exemption and over the data to be collected. Secondly, the NWWRAC paper notes that where vessels have been shown not to catch cod, then the exemption should be provided within a shorter time frame. However, the Workshop notes that the provisions under Article 14 could have been used within a MS to provide groups of vessels with effort levels deemed appropriate. The lack of clear guidance and lack of standardised data requirements has likely contributed to the view that there is a lack of transparency in the criteria needed to achieve exemption and the associated data needs. Clearly, the process has evolved since the introduction of the plan, and this has led to the view of ‘moving goalposts’; STECF continues to advise on whether there is a risk that low cod catches are due to the severely depleted nature of the stocks rather than any active measure. In the case of exemptions based on spatial decoupling, consideration will need to be given to the potential for increases in effort in localised areas on species other than cod. This attains additional importance if, over the course of time, the exemption attracts additional vessels.

### *5.3.4. Interpretation issues of Article 12.*

Article 12(4) refers to the baseline effort as defined in Art 12(2): in the first year (2009) it is equal to the average over either 2004-2006 or 2005-2007, which is higher than the effort in 2008; in subsequent years it is equal to the maximum allowable effort of the previous year. This leads to a situation where the effort reductions are not in line with the reductions in F; for example, if in 2009 F stipulated by 8(3) is 75% of F in 2008, the effort in 2009 stipulated by 12(4) is more than 75% of that in 2008. With reference to the cod stock in the North Sea, Table 5.1 illustrates this.

**Table 5.1** Relative target effort based on Article 12.

| | Stipulated fishing mortality | Stipulated effort |
|---|---|---|
| 2008 | 100% | (actual effort in 2008) |
| 2009 | 75% (cf Art. 8(3)) | 75% of the baseline (which is higher than the effort in 2008) hence **>75% of effort 2008** |
| 2010 | 65% (cf Art. 8(3)) corresponding to 86.7% of F2009 | 86.7% of the maximum allowed in 2009 = 65% of the original baseline (which is higher than the effort in 2008) hence **>65% of effort 2008** |

A second problem concerns the fact that multiple interpretations of Article 12(4) are possible.

The successive decrements of 10% in Art 8(3) can be either viewed as decrements in the percentage of the 2008 value (55%, 45% etc.), or as year-on-year reductions by 10% of the previous year’s value (resulting in respectively 58.5% and 52.65% of the 2008 value). The first of these interpretations leads to ever increasing year-on-year reductions in effort: 2011/2012 – 18%; 2012/2013 – 22%; 2013/2014 – 29%; 2014/2015 – 40%, etc., and eventually to negative effort. The Table 5.2 illustrates this.

**Table 5.2** Projected relative effort based on different interpretations of Article 12

| | Interpretation 1 | | Interpretation 2 | |
|---|---|---|---|---|
| | % relative to 2008 | % reduction relative to previous year | % relative to 2008 | % reduction relative to previous year |
| 2008 | 100 | | 100 | |
| 2009 | 75 | 25 | 75 | 25 |

| | | | | |
|---|---|---|---|---|
| 2010 | 65 | 13 | 65 | 13 |
| 2011 | **55** | **15** | **59** | **10** |
| 2012 | **45** | **18** | **53** | **10** |
| 2013 | **35** | **22** | **47** | **10** |
| 2014 | **25** | **29** | **43** | **10** |
| 2015 | **15** | **40** | **38** | **10** |
| 2016 | **5** | **67** | **35** | **10** |
| 2017 | **-5** | **200** | **31** | **10** |

Another interpretation takes the actual current-year predictions of the F values into account: the value predicted for the intermediate year (e.g. as status quo) and the value for the TAC year when under full consideration of Article 8 (i.e. 8(3) as well as 8(5) limiting year-on-year TAC changes to 20%). For example, in 2010 for the North Sea F2010 was assumed equal to the F2009 estimate; F2011 was estimated corresponding to TAC2011 as stipulated by Art 8(5); the % effort reduction was then advised to be set as F2011 relative to F2010 (in this case 0.48/0.85 = 56%).

The EWG would like to point out that multiple interpretations are possible under the current phrasing but will not argue that one or the other of these interpretations is the correct one. The EWG recommends that the regulation should clearly and unambiguously point to only one interpretation.

### *5.3.5. Interpretation issues of Article 13.*

The group noted the following interpretation issues with Article 13.

- From the phrasing of 13.2(b) it is not clear whether a vessel is required to opt in for all its trips; if this is not the case, a vessel could have some trips, with >5% cod in the catch, covered by the normal effort limitation and some trips, with <5%, covered by the increased effort provision of this Article.
- In Article 13.7 STECF is requested to compare the reduction in cod mortality which would result from the application of 13.2(c) with the reduction STECF would have expected to occur as a result of the effort reduction of 12(4). Even in case an analytical assessment does exist, this can only be established *post hoc* and subject to e.g. (retrospective) bias and imprecision in the F estimate. The problem can be illustrated with the example of the Real Time Closures under the Scottish Conservation Credits (SCC) scheme (see PLEN-10-02). Here, it was *a priori* calculated how much the fleet's catches needed to be reduced to remain in line with the overall F implied by the TAC stipulated by the HCR of the plan. However, *post hoc* it appeared that the TAC had not resulted in the intended reduction of the estimated F but rather in an increase, although the partial F of the fleet operating under the SCC had increased to a lesser extent. Thus, as far as the *a priori* knowledge goes, the SCC was appropriate; only *post hoc* because the TAC appeared less effective than intended the SCC seemed not appropriate 'to the letter'.
- Another problem becomes clear if we follow the regulation to the letter: If, for example, the conditions of Article 7.2(a) were the case, stipulating that F must be reduced by 25%, it directly follows that according to Article 12(4) effort must be reduced by 25% and that the activities under 13.2(c) must cause a reduction in F of 25%. Here, according 'to the letter',

percentages are set to be equal without overtly stating that this is based on the implicit assumption of proportionality. However, in Article 13.7 STECF is requested to compare the reduction in cod mortality which would result from the application of 13.2(c) with the reduction STECF would have expected to occur as a result of the effort reduction of 12(4). It is unclear whether it is implied here that STECF should expect the relation between effort and F to be proportional. As argued in section 5.5.3, under some conditions F might be expected to be reduced by only a few % under an effort reduction of 25%. In that case, if Article 13.7 is to be taken to the letter, the reduction of cod mortality resulting from a particular MS's application of 13.2(c) would only have to be of a few % in order to compare favourably to STECF's expectations. It is unclear whether the intention of Article 13.7 is that its application should result in the % reduction as stipulated under Article 12(4) – in this example 25% – under the implicit assumption of proportionality.

- Article 13(4) refers to the maximum level of effort that can be allowed through the buy-back provisions: it has been interpreted as 'no more than the level of the previous year' but also as 'up to the original baseline (of 2004-2006 or 2005-2007)'.
- It was noted that 13.7 does not ask STECF to advise on the uptake of provisions 13.2 (a,b, and). Article 13.3 states: "Vessels referred to in paragraph 2 shall be subject to increased frequency of monitoring", but it is not stipulated in the regulation (i) to what extent frequency of monitoring should be increased (ii) whether and by whom and with what consequences the results of this monitoring will be assessed.
- Article 13(2.a) based on 1% cod catch appears unnecessary given a less restrictive derogation seems to be possible under Article 11(2.b), related to 1.5% cod catch.

### *5.3.6. Interpretation issues of Article 14.*

Article 14 addresses the proportionality with respect to allocation of maximum fishing effort and quota within a Member state to the vessels flying their flag, allowing for allocation towards vessels performing 'good behaviour'. Feedback from Member States indicates a low level of application of Article 14. France is the only Member State that indicated specific implementation through the issuing of special fishing permits to vessels in compliance with points 2, 3 and 4 of Article 14.

There are various initiatives within Member States related the criteria set out in Article 14(1), e.g., enhanced data collection schemes, cooperative programmes to reduce cod by-catch and discards, measures to reduce fuel consumption. There has, however, been no feedback from Member States explicitly relating these initiatives to Article 14 or where it directly affects the proportional allocation of effort or quota to individual vessels (or group of vessels).

### *5.3.7. Interpretation issues of Article 17*

Article 17 of Council Regulation No 1342/2008 ("long-term plan for cod stocks") provides a mechanism whereby Member States can transfer effort across gear groupings in the same geographical area. This mechanism is in place so that changing fishing practices are able to be reflected in the effort management scheme.

Such a movement of effort is subject to the conditions set out in article 17(2-5). The main condition is that such transfers are undertaken with a 'correction factor' (17(4)) when the recipient vessels have a higher cod catch rate than the donor vessels. The correction factor is required to reflect the relative cod catching ability of the gear, based on the catch per unit effort (cpue) averaged over the last three years (17(2)). Where the transfer occurs to a recipient vessel with a lower catch rate no correction factor is applied, and the transfer takes place on a 1 Kw day – 1 Kw day basis (17(3)).

## 5.4. Enforcement and Compliance

### *5.4.1. Effectiveness of Article 7 and 8.*

As discussed above for three of the stocks the main control articles were severely hampered by a lack of stock assessment.

There are a number of examples of Harvest Control Rules being established for stocks without analytical assessment and forecast, and this could provide some inspiration for designing LTMP in simpler and consistent ways. These rules would build on biomass levels rather than exploitation levels, as these may often be more easily available.

For European stocks, a LTMP could be designed alongside the ideas developed in either the most recent ICES MSY framework[1], or the categories from the 2010 EC Policy Statement (COM(2010)241 final)[2], as both frameworks have emerged after intensive scientific considerations, consultations with clients and stakeholders and ongoing adjustments, in order to best cover the great diversity of situations across all European stocks. The 2010 Policy Statement included 11 categories, of which 4 (categories 6 to 9) dealt with stocks whose status is not known precisely. A number of quantitative rules were also suggested for assessing if a stock is increasing or decreasing, for example "If the average estimated abundance in the last two years exceeds the average estimated abundance in the three preceding years by 20% or more, a 15% increase in TAC applies". So it is considered that such rules could potentially be investigated further and form the basis of a long-term management plan.

Another source of inspiration could come from Alaska, where a 6-Tier system for Harvest Control Rules has been in place since 1998. A detailed description of the system can be found on the Alaska Fisheries Science Center[3], and a scientific and sociological analysis of it was performed by European scientists during the CEVIS EU research project (Wolff and Hauge, 2008[4]). This is also described in the WD in Annex 4. In short, each exploited stock, including bycatch, endangered and non-commercial species, is assigned to a tier, based on the level and quality of biological information available. The tier then defines the Acceptable Biological Catch and Overfishing Level. Tiers 1 to 3 basically require age-structured models, and each of these Tiers consists of a 3-part rule, reflecting the state of the stock related to Bmsy. Tiers 4 to 6 are a one-part rule and apply to stocks without analytical assessment. Tier 4 is based on Yield Per Recruit, Tier 5 on estimates of biomass and natural mortality, and Tier 6 is an upper catch limit which works largely like the category 11 from the 2010 EC Policy Statement paper.

In general, the tier system provides precautionary management. Stock abundances are historically high for several stocks. While the design of some of rules is still questioned, all parties seem to have confidence in the Tier system and how it is used.

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1 http://www.ices.dk/committe/acom/comwork/report/2011/2011/General%20context%20of%20ICES%20advice.pdf

2 http ://ec.europa.eu/fisheries/cfp/fishing_rules/tacs/index_en.htm

3 http://www.afsc.noaa.gov/REFM/docs/2010/BSAIintro.pdf

4 Wolff, F., and Hauge, K.H., 2008. Fisheries management innovations in Alaska: a case study report. Chapter 1 in Aranda (Ed.), 2008: Evaluation of innovative approaches to fisheries management outside the European Union: The cases of Alaska (USA), Canada, Iceland and New Zealand. Combined Deliverable D5 and D6, CEVIS Project (No 022686). http://www.ifm.dk/CEVIS/CevisProducts.htm

### 5.4.2. *Effectiveness of Article 11.*

Very few applications have been approved for derogations under Article 11 (see Section 5.3.3). However, those that have been approved appear to be effective, as catches of cod under this derogation can be considered negligible. (Table 5.4.1)

**Table 5.4.1** The percentage of the catch of cod taken in fleets operating under Article 11 derogation (total cod catch is <1.5% of total catch).

| Stock/Area | 3a Kattegat | 3b North Sea | 3c Irish Sea | 3d West of Scotland |
|---|---|---|---|---|
| Cod catch taken under Article 11 segments/ total regulated cod catch | 5.0% | 0.22% | 0% | 1.0% |

### 5.4.3. *Effectiveness of Article 12.*

The objective of the plan 1342/2008 is "to ensure sustainable exploitation" for the respective cod stocks through achieving fishing mortality rates (F) of 0.4 or below. In practice, while fishing mortality rates are currently too high, this means the plan's objective is to reduce them to the level of 0.4

**Traditional instruments**

To achieve and regulate the F targets the plan deploys two traditional instruments, namely TACs (total allowable landings)[5] and effort limitations, and one novel instrument, in the form of Article 13 (see below). Of the traditional instruments we have learned over the past decades that they have generally failed to control the fishing mortality rate, in particular in the case of mixed fisheries.

- The setting of TACs only limits the landings but not the catches, and especially in mixed demersal fisheries there are various incentives for legal discarding of overquota and undersized catches. The assumption that TACs limit total removals is undermined by the recent increased discarding of older, above minimum landing size, cod seen in both the North Sea (WGNSSK, 2010) and West of Scotland (WGCSE, 2010). For example WGCSE (2010) noted that for the West of Scotland cod removals exceed the agreed TAC by approximately 7 times.
- The setting of effort limitations is based on the assumption of proportionality between overall effort and F, which is known to be generally violated for various reasons, e.g. targeting behaviour and aggregation of the species leading to hyper-stability of CPUE (Harley et al. 2001); this has been pointed out several times by STECF (e.g. PLEN-10-02) and is discussed in section 5.5.3. in more detail.

Due to these limitations, neither the use of TAC (as total allowed landings) nor the proxy use of effort constraints to regulate catches, have been able to adequately control cod removals. Reliance on

[5] It has long been tacitly understood that 'TAC', 'Total Allowable Catch', is implemented as total allowable landings only while discarding overquota catch is legal. Nowadays, especially in the context of 'catch quota', the word 'catch' is more often taken to mean total removals by fishers, i.e. landings + discards, except in the phrase 'TAC' (where it continues to refer to landings only). If TAC were to be interpreted as 'total allowable landings + discards' it would become a more appropriate management tool. Control, and even the scientific recording, of catches (rather than landings) will then need different methods.

these control measures is one core failing in the plan and can be considered a major deficiency in the design of the plan.

### 5.4.4. *Uptake of Article 13 derogations.*

Member States' usage of the provisions of Article 13 to increase effort

| | 2009 | | | | | 2010 | | | | | 2011 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MS | notification 13(5)? | report 13(6)? | extra effort used? | concerns 13(2c)? | STECF advice asked? | notification 13(5)? | report 13(6)? | extra effort used? | concerns 13(2c)? | STECF advice asked? | notification 13(5)? | concerns 13(2c)? |
| DK | Yes | Yes | No | Yes | No, since effort was not used | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| DE | Yes | Yes | No | No | No, Art 13(2c) not involved | Yes | Yes | Yes | No | No, Art 13(2c) not involved | Yes | No |
| NL | Yes | No | No | No | No, Art 13(2c) not involved | | | | | | Yes | Yes |
| SE | Yes | No | No | Yes | No, since effort was not used | | | | | | | |
| FR | | | | | | Yes | Yes | Yes | No | No, Art 13(2c) not involved | Yes | No |
| IR | Yes | Yes | Yes | Yes | Yes, but advice not given owing to unavailability of information | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| UK | Yes | Yes | Yes | Yes | Yes, advice given in PLEN-10-02 | ? | Yes | Yes | Yes | Yes | | |

**The 2009 management period**

In the text table it can be seen that Article 13 has been used by various Member States. In the first management period (2009) six Member States notified the Commission in accordance with Art 13(5) of their intention to use extra effort under the provisions of Article 13. The requests of Denmark, Sweden, Ireland and the UK involved Art 13(2c). The German request included vessels for which exemption under Article 11 was denied in 2009. Only three Member States, Germany, Denmark and the UK, reported on the effort used in the 2009 management period, in accordance with Article 13(6). In the cases of Germany and Denmark their effort use was below the initially allocated maximum allowable fishing effort and hence the extra effort was not taken up. Sweden and the Netherlands did not provide the report in accordance with Article 13(6), but in the case of the Netherlands in the Commission inspection mission in 2010 it was verified that the Netherlands had in actual fact not taken up its increased effort. Also Sweden had not taken up its increased effort. Only Ireland and the UK seem to have taken up their increased effort. As stipulated in Art 13(7) the Commission requested STECF advice for the cases of the UK and Ireland; STECF gave advice concerning Scotland in its summer plenary meeting of 2010 (PLEN-10-02) but not for England, Wales, Northern Ireland, nor Ireland because no information had been made available. No STECF advice was asked for the other two cases where Art 13(2c) was concerned as stipulated in Art 13(7), because – as it turned out – the extra effort was not taken up. STECF advice is not required if Art 13(2c) is not involved.

**The 2010 management period**

Four Member States, Denmark, Germany, France, and Ireland, notified the Commission in accordance with Art 13(5) of their intention to use increased effort in the 2010 management period. These Member States and also the UK submitted reports on used effort in accordance with Article 13(6); all Member States used (some of) their increased effort. Three cases, Denmark, Ireland, and the UK, involved Art 13(2c), and the Commission requested STECF advice as stipulated in Art 13(7); for Ireland and Denmark this advice was given in the STECF spring plenary meeting of 2011 (PLEN-11-01); it is expected that STECF will give advice concerning the UK in its summer plenary meeting when all information from the stock assessments becomes available.

**The 2011 management period**

Five Member States, Denmark, Germany, the Netherlands, Ireland, and France, notified the Commission in accordance with Art 13(5) of their intention to use increased effort in the 2011 management period; three cases, Denmark, the Netherlands, and Ireland, involve Art 13(2c). Since this period is not over yet, no reports on used effort in accordance with Article 13(6) have been submitted yet. The Commission did not yet request STECF advice in accordance with Art 13(7).

### *5.4.5. Effectiveness of Article 13.*

Article 13 is, to our knowledge, an entirely new management instrument. It reflects the EC's paradigm shift towards strengthened participation in fisheries governance (Green Paper on the CFP, 2009). According to this Green Paper, the general framework for fisheries policy would be set on the basis of a Commission proposal, but detailed implementing decisions, for example, on types of gear or on which area should be closed to fishing and when, could then be taken at a regional level where scientists would need to interact with stakeholders and governments. The Green Paper also foresees that the industry is asked to develop its own fisheries plans, for which they would need scientific advice – especially if this is to form part of a results-based management system. Current thinking in fisheries management is that such practices are more likely to be successful with regards to achieving the objectives.

Article 13 provides incentives for cod avoidance in the form of an increase in allowable effort if cod-avoidance measures are undertaken. The way in which cod avoidance may be achieved is left open to be decided by the Member States and the industry, e.g. through the use of highly selective gear, or spatiotemporal modifications of fishing activity. As such, Article 13 is an innovative instrument following the new paradigm.

The objective of Article 13 – cod avoidance in terms of real catches incl. discards – clearly conforms to the plan's aim: in order to reduce fishing mortality on cod, catches of cod need to be avoided. The other instruments (limiting landings or effort) are more indirectly related (if at all) to fishing mortality. Thus, in principal at least, it appears more appropriate (in terms of actually achieving reductions in F on cod) to use measures that actually achieve reductions in cod catches rather than proxy (effort) and ineffective (TAC) tools. It may be more appropriate to encourage the avoidance of cod catches as the primary focus of the plan and to use effort reductions as an 'encouragement (stick)' to engage in actual fishing patterns that achieve reductions in cod catches. Article 13 also allows for measures tailored at a finer scale to specific fisheries than the grand-scale overall TACs and effort limitations do.

For these three reasons – (i) the following of the new paradigm of participatory governance and results-based management; (ii) the more direct relation to the objective through controlling the actual catches; and (iii) the potential for fine-tuning of measures to specific fisheries – Article 13 should be seen as the cornerstone of the plan.

*Problems identified with the implementation of Article 13*

The practical implementation of the cod avoidance articles has however, been questionable, has not yet been subject to thorough review and is complicated or impossible for areas where there is no analytical assessment (for F), specifically the requirements of article 13.2(c).

Article 13 provisions allow for reclaim of effort in the following ways:

13.2. The maximum allowable fishing effort may be increased within effort groups in which the fishing activity of one or more vessels:

> (a) is carried out having on board only one regulated gear the technical attributes of which result, according to a scientific study evaluated by STECF, in catching less than 1 % cod (highly selective gear);
>
> (b) results in a catch composition of less than 5 % cod per fishing trip (cod-avoiding fishing trips);
>
> (c) is conducted in accordance with a cod avoidance or discard reduction plan which reduces fishing mortality for cod among participating vessels by at least as much as the effort adjustment referred to in Article 12(4); or
>
> (d) is carried out in the west of Scotland area to the west of a line drawn by sequentially joining with rhumb lines the positions laid down in Annex IV of the regulation measured according to the WGS84 coordinate system, provided that the participating vessels are equipped with satellite-based vessel monitoring systems (VMS).

Given the provisions of Article 11.2, exempting vessels that demonstrate that cod catches are below 1.5% of the total catch, the inclusion of 13.2(a) seems unnecessary – why would vessels that can show cod catches below 1% not apply for exemption under article 11? Unless there is an implementation issue, e.g. have demonstrated or notified the use of highly selective gears under article 11, but then fail to use it, this seems an unnecessary provision in the regulation.

Article 13.2(b) using percentages of catch, while attractive from a monitoring perspective, may not necessarily achieve the desired reductions in F and may favour smaller mesh fisheries which inherently may have ‘high’ overall catch (in fact this could conflict with the promotion of more selective gears).

With regards to Article 13.2(c) it is difficult to disentangle the effects of specific and multiple measures on F, particularly when the entire fleet participates in the programme (as in the Scottish case) because there is no possibility to compare against vessels that are not participating.

With respect to Article 13.2(d), there is evidence from Scottish VMS-linked logbook data (see PLEN-10-03) that would suggest that there are ‘significant’ cod catches west of the management line. ICES (2010) noted that ~60% of UK cod catches were taken west of the line. A more detailed analysis of cod catches by MS in this area is required and MS should be asked to submit spatially refined cod catch (from observer trips) and landings data.

Whereas the TACs and effort limitations are, through the stipulated procedures for their setting, at least in intention numerically related to the (change in) fishing mortality rate as prescribed by the HCR, this is not the case for most of the provisions of Article 13. Therefore it is difficult to evaluate the appropriateness of the Article. According to 13.2(a) effort increase is allowed when gear is used which results in having less than 1% cod in the catch. The extent of effort increase is not specified in the regulation (except for an upper limit). Therefore, it is left undetermined to what extent this provision will contribute towards the aim of reduction of cod F. Also, there is no *a priori* clear relation between the percentage of cod in the catch composition and the fishing mortality rate of cod. A low percentage may be achieved when (local) abundance is low but in such a case it would represent a high F. A low percentage may also be achieved by increased catches of other species (e.g. while keeping cod catches at similar levels). Furthermore, if many vessels have 1% cod in their catch, the total amount caught may still be high. The same deficiencies exist in the regulation with regards to 13.2(b), which allows effort increase when less than 5% cod per fishing trip is achieved, and to some extent with regards to 13.2(d), which allows effort increase for vessels fishing west of the management line (where cod abundance is expected to be low because it is supposedly mainly outside the depth range of cod). Because of these deficiencies, it is not possible to assess *a priori* how appropriate these provisions actually are. Nevertheless, for the *post hoc* evaluation of the effectiveness of the provisions (whether they have actually resulted in a decrease in fishing mortality rate), catch and effort data of the relevant vessels might be compared with catch and effort data of similar vessels that were not operating under these special conditions, and if estimates of fishing mortality rate are available their contribution to the change in F might be estimated.

Special condition 13.2(c) poses a different problem. It is explicitly and exactly related to the aim of the plan, in that it stipulates that the vessels can do anything which results in the same reduction in fishing mortality as stipulated by the HCR. In that sense, it is by definition appropriate. However, whether a proposed cod avoidance plan qualifies for 13.2(c) can in principal be determined only to the extent to which fishing mortality can be estimated (*post hoc*) if the Article is taken 'to the letter'. This can be seen as a flaw in the design or formulation of the plan.

*New paradigm – new problems – new solutions*

The difficulties regarding Article 13 outlined above, in particular those pertaining to 13.2(c), may be unavoidable under the new paradigm. Perhaps the new paradigm does not allow for very strict assessment of compliance and effectiveness. Perhaps we need to find new ways of how to determine whether results-based management achieves its objectives; we need metrics that are measurable on the time-scale on which we want to evaluate effectiveness. Compliance in results-based management is by definition difficult to establish, because results-based management implies that fishers are allowed to do anything so long as it results in achieving the objective. Then, the assessment of compliance and the evaluation of effectiveness merge into one another, and probably have to be deferred a few years into the future, when it can be more reliably detected (estimated) whether the intended reductions in F have actually occurred and the objectives been achieved. In that case, monitoring whether the plan functions as it should and whether it modifies behaviour in the right direction becomes a more important aspect of the evaluation. Annual metrics could then focus more on changes in fisher behaviour, e.g. changes in catches and discards, shifts in effort allocation to certain gears, métiers, areas and periods in relation to cod concentrations, while conventional metrics on the status of the stock should perhaps be evaluated at longer time scales. While fisheries managers will have to get used to the new paradigm and its opportunities and limitations, another promising paradigm shift is happening: real-time high-resolution spatiotemporal data on fishing activity (VMS) and catches (electronic logbooks and fully documented fishing) are becoming available. These will allow for management measures to be set at a finer spatiotemporal scale and tailored at a finer scale to specific fisheries than the grand-scale overall TACs and effort limitations which are based on rough large-scale annual estimates at the level of large management area.

### *5.4.6. Effectiveness of Article 14.*

As the uptake under this article has been very limited or at least reported as such, the effectiveness appears to be limited.

### 5.4.7. *Effectiveness of Article 17.*

The implementation aspects of Article 17 are noted in Section 5.3.7, the use of the Article is discussed here.

Two options are available to member states wishing to transfer between effort groups. The first is based on the cod catch and effort data submitted to STECF Effort EWG each year; CPUE estimates are derived for each area and gear group aggregated across all member states. These international transfer ratios are then applied when transferring between gear groups. Secondly, in the event that the CPUE estimates from individual member states differ by more than 15%, then member states can, on application to the Commission, apply national transfer rates. In some cases there has been a structural change in fishing practices or where other EC regulations have prohibited a particular gear group, for example the introduction of new technical measures or where particular gear groups are no longer in use. This can potentially result in member states permanently redistributing effort from one gear group to another if they wish to use their historic entitlement. This can result in two issues. If these gear groups had similar CPUE rates to the international estimates, then the effort is transferred based on the international rate. However, in situations where the historic difference in CPUE was greater than 15% below the international level, member states could potentially be penalised as it is no longer possible to gather data on which to base the 3-year average. This could potentially limit the development of new fisheries, owing to the lack of effort, that may wish to use gear and mesh bands associated with historic fishery but for targeting different species.

### 5.4.8. *Conclusions to review of regulation Articles.*

In all of the stock areas the total recorded effort by the gears for which cuts applied declines slightly, but did not decline, in 2009 and 2010, in line with the reductions according to the plan. Some of this lack of reduction is associated with cod avoidance measures, implying that mortality should have decreased, however, not all fleets that failed to deliver reductions were involved in measures under Article 13.

In summary, by defining catch limits in terms of catch composition, i.e. as % of the total catch, there are perverse drivers, and the total catch of cod of a group of vessels is not considered. Currently, under various derogations, fleets are allocated effort regulatory status based on a percentage of cod in their catch. However, this criterion does not directly relate to the fleet’s total catch of cod, or the partial fishing mortality of that fleet segment. If, for example, each fleet segment or vessel was allocated a total allowable catch of cod (landings and discards), this would provide fishermen with a target that is directly measurable by them and relates well to fishing mortality on cod. It would still be necessary for this catch to be monitored to show that this had not been exceeded (as is currently the requirement under Article 11/13 criteria). By using catch as the measure rather than F, which fishermen cannot measure or monitor, the responsibility for estimating the catch that leads to the target F required by managers lies appropriately with the scientists, but the managers and fishermen have a responsibility to monitor and control catch, something they can be requested and expected to measure under current logbook regulations.

In this context we recommend (i) that catch limitations refer to all catches (landings plus discards) and that high-coverage of monitoring of the catches (and compliance with the catch quota) is in place (e.g. fully documented fishing through cameras on board); this way the fishers will experience internalisation of the costs of discarding, which they will then have to take into account in their business decisions; (ii) that through the participatory governance, such as in Article 13, stakeholders are encouraged to phrase plans that suit their fishery practices on a fishery-by-fishery basis; this will result in greater stakeholder buy-in and compliance; (iii) that flexibility is allowed at a fine spatiotemporal and fishery-by-fishery level suited to the actual stock distribution and the fishing practices – different options should be available to the individual fisher; this will help to prevent perverse incentives; (iv) metrics as well as an appropriate time-scale to measure them are established to evaluate effectiveness of the management measures (e.g. catches, effort allocation to métiers, areas and periods at an annual time scale, stock status parameters at a longer time scale); this will help evaluating whether the measures are appropriate for achieving the objectives; and (v) if the approach was taken (as suggested above) that fleets for which managers request different effort regulatory status because of low cod catch (Article 11 type) would be allocated a total allowable catch of cod, as a portion of the total MS's quota, managers would be required to demonstrate that these cod catches are not exceeded. However, the detailed monitoring required could be costly, particularly if a small part of the total national catch of cod is taken in a small bycatch fishery that is expensive to monitor. Managers should then be given the option to either allocate a very small but sufficient portion of the national quota to these vessels and take on the burden of detailed monitoring, or alternatively allocate a larger portion of the national quota to these vessels using a less precise monitoring method. It would then be cheaper to demonstrate that the larger portion quota was not exceeded.

## 5.5. Additional general reviews on the effectiveness of recovery plans and effort management will be provided as follows:-

### *5.5.1. Uncover project review:*

The UNCOVER project 'Understanding the mechanisms of stock recovery' Project no. 022717 (SSP 8) was funded under the EU 6th Framework Programme. It examined in detail responses to management and biological stimuli in the following stocks: Norwegian and Barents Seas (Northeast Arctic cod, Norwegian spring-spawning herring, Barents Sea capelin), the North Sea (North Sea cod, Autumn spawning herring, North Sea plaice), the Baltic Sea (Eastern Baltic cod, Baltic sprat) and the Bay of Biscay and Iberian Peninsula (Northern hake, Southern hake, Bay of Biscay anchovy).

UNCOVER's objectives were to identify changes experienced during stock depletion/collapses, to understand prospects for recovery, to enhance the scientific understanding of the mechanisms of fish stock/fishery recovery, and to formulate recommendations how best to implement LTMPs/recovery plans.

UNCOVER identified the developing of LTMPs with Management Strategy Evaluation (MSE) as key to creating plans that work. UNCOVER emphasized that it is essential to set realistic long-term objectives and strategies for achieving successful LTMPs/recovery plans. UNCOVER recommended that such plans ideally should include:

1) Consideration of stock-regulating environmental processes;
2) Incorporation of fisheries effects on stock structure and reproductive potential;
3) Consideration of changes in habitat dynamics due to global change;
4) Incorporation of biological multispecies interactions;
5) Incorporation of technical multispecies interactions and mixed-fisheries issues;
6) Integration of economically optimized harvesting;
7) Exploration of the socio-economic implications and political constraints from the implementation of existing and alternative recovery plans;
8) Investigations on the acceptance of the plans by stakeholders and specifically incentives for compliance by the fishery;
9) Agreements with and among stakeholders.

An analysis by UNCOVER of the development and success of fish stock/fishery recovery plans in Australia, Europe, New Zealand and the USA, based on information collected at the project's start, showed that the four best combined factors able to predict successful stock/fishery recovery were:

a) the rapid reduction in fishing mortality;
b) the environmental conditions during the recovery period;
c) life history characteristics of fish stock;
d) management performance.

UNCOVER considered that "recovery is more likely when fishing effort reductions occur through regulating days at sea and decommissioning, and inclusion of harvest control rule (HCR) schemes, and there are positive recruitment events during the recovery period either stimulated by or coincident with effort reductions. Socio-economic factors such as governance and wider stakeholder participation are playing an increasingly important role."

UNCOVER concluded that "a substantial and rapid reduction in fishing mortality is a key factor contributing to the overall success of a recovery plan, whereas 'too little, too late' catch reductions delay the onset of recovery or prevent recovery at all. The key is the speedy initial reduction in fishing mortality. This is because the effect of small reductions may easily be subservient to the uncertainty of the assessments. As a result of small reductions there will probably be a sequence of years in which recovery responses are not evident, whereas the public debate on further reduction of TAC and quota will be continued year after year, as a process undermining the credibility of the scientific advice if the effect of previous reductions cannot be shown."

UNCOVER identified that preserving the stock's reproductive potential is critically important. "Process studies revealed that sexual maturation schedules are linked to growth rates and in turn are related to population densities or sizes, thus maturation at an earlier age tends to be linked with lower population sizes rather than larger populations."

UNCOVER noted that the consequences of changing habitats can influence recovery: "Stock production and recovery dynamics depend on the availability of preferred habitat conditions at various stages of ontogeny which influence optimal growth, spawning, recruitment and survival. These habitats are defined by abiotic and biotic convictions such as temperature, salinity, oxygen, food type and availability, ocean currents, and limitations on pollution or other forms of human encroachment that degrade habitats." "Favourable environmental conditions are associated with successful stock recovery but are not alone in influencing recovery."

UNCOVER noted the effects of multispecies interactions: "Multispecies interactions and trophic controls have a strong influence on stock recovery potential, and the magnitude of impacts depends on the prevailing environmental conditions. Predation on small fish has a high impact on recruitment success and hence recovery potential of commercially important fish species. Density dependent (i.e., intraspecific) but often more important interspecific trophic interactions lead to different and mostly slower recovery rates of depleted fish stocks, compared to single species predictions."

#### Conclusions to UNCOVER review

The most important messages for managers from the UNCOVER project are

- The need to test policies by MSE, including fishery interactions.
- If reductions in fishing mortality are required then implement a large change quickly, rather than expect a slow decline to work.

### *5.5.2. Review of Faroes effort management:*

A detailed review and some analyses of the Faroese effort management is available in Jákupsstovu et al. (2007) and Baudron et al. (2010), and the summary here draws on a more detailed analysis in Annex 5.

The Faroe Islands have received growing interest as a case study where relevant lessons could be learned. In the mid-1990s, the TAC system in place was rejected by the fishing industry and the authorities because it resulted in extensive discarding when single-species quotas were filled. Therefore, owing to the general dissatisfaction, the Faroese Parliament developed in 1996 a new management system in close cooperation with the fishing industry for all vessel groups targeting demersal stocks on the Faroe plateau. This new system (referred to as total allowable effort, TAE) consists of individual transferable effort quotas (fishing days) for each fleet category. Additional measures such as area closures during the spawning seasons, area restrictions for larger vessels, and minimum gear mesh sizes were also implemented. This represents therefore a unique system of pure effort-regulation in a mixed groundfish fishery.

The initial allocation of fishing days was based on an estimated historical allocation from data on partial fishing mortalities. It was also estimated that sustainability of the fisheries could be achieved by a target fishing mortality (F) of 0.45 for each stock. Subsequently, the number of fishing days allocated has been regulated each year based on ICES advice and input from the fishing industry.

After more than ten years of implementation, an empirical assessment of the practical effects of this management system was conducted (Jákupsstovu et al., 2007). Globally, it was concluded that Faroese effort management had not achieved its objectives, and among others that the target of F=0.45 had not been achieved.

Only after this evaluation did cod F decrease to 0.45; but ICES considers anyway this generic target to be inconsistent with both precautionary and MSY considerations, as Fpa and Fmsy are significantly lower for all three stocks.  In 2011, ICES advice was for an F reduction of 30% and 38% for cod and saithe respectively, and no directed fishery on haddock.

A major issue is that over at least the first ten years of implementation (recent effort updates not being available in the ICES advice book) the total number of fishing days allocated has been reduced by less than 2% per year in average, significantly less than advised by ICES for the same period. In addition, the allocated fishing days were never fully utilized, however, which suggests that the initial effort allocation was too high to constrain *F* to the target. In practice, effort management did not act as a restrictive and reactive management tool, but rather as a conservative *status quo*.

One of the most fundamental assumptions behind the effort management system proved also to be challenged. The fleets were expected to target the most abundant fish species, thus reducing the fishing mortality on stocks that are in bad shape. However, low prices on saithe and haddock and high prices for cod have kept the fishing mortality high on cod; the economic factors seem to be more important than the relative abundance of the stocks in determining which species is targeted (ICES advice 2011).

Overall, the conclusions reached by Jákupsstovu et al. (2007) and Baudron et al. (2010) were that the most important issue in the Faroese fisheries management was not the effort-based system itself, but rather its inability to adjust to scientific recommendations and to variability and trends in catchability. This in turn is linked to the fact that the initial effort was set by Faroese authorities too high, and it could not be reduced easily thereafter. A sustainable TAE system can be accommodated only if the initial effort level is set sustainably, as there appears to arise more resistance to large cuts in effort than large cuts in single-species TACs (implemented as TALs).  But allowing for adequate year-on-year flexibility, the TAE would appear to be a more sustainable and economically robust management strategy than TAC-based management, considering the fluctuations in the single-species HCR and the extensive discarding this could create.

This conclusion is consistent with the UNCOVER findings described above, that initial large decreases in fishing mortality/fishing effort are more efficient than small annual downwards adjustments.

### *5.5.3. F-Effort studies:*

The cod plan, in its aim to control fishing mortality (F) on cod, heavily relies on the assumption of proportionality between fishing effort and F. The proportionality assumption may seem valid intuitively but it actually depends on many hidden assumptions which are usually violated (‘all else being equal’ is such a tacit assumption).

The Working Document (Annex 6) reviews some published studies that identify factors influencing the partial F exerted per unit effort (Fpue) by a vessel which may thus deteriorate the proportionality. These factors include skipper skills, auxiliary equipment, gear, as well as the area and the season of the fishing operation, costs, revenues, and other incentives, leading to business decisions such as targeting or avoidance.

This implies that, depending on the predictability of catchability by fishers, management-imposed reductions in effort might not translate directly into a proportional reduction in F. Another effect is that spatial distribution of a stock may contract with declining population biomass, without affecting the fish densities in the core habitat of the species. When fishers are mainly fishing these core habitats, contraction of the spatial distribution will result in a 'hyper stability' of the catch rate. Thus, if fishers faced with effort reductions 'contract' their activity to these core habitats, they may still achieve high catches despite the reduced effort.

The conclusion from the review is that in general it is unlikely that effort reductions will lead to proportional reductions in F; under effort reductions it is most likely that the non-proportional relation is convex, implying that F decreases to a lesser extent than effort.

The Working Document also presents a 'quick and dirty' illustration of this principle in order to gain some idea of the lower bounds of expected % reduction in F under a given % reduction in effort (under the extreme, and unrealistic assumptions that (i) the fleet segment maximizes their revenues and (ii) fishers have perfect knowledge of spatiotemporal catchability, and (iii) catches are not restricted by quota). It is concluded that, depending on fisher behaviour, a 25% effort reduction may result in anything between a few % and >25% reduction in F.

The results in Annex 6 also indicate that directed and bycatch fisheries may be different: the relationship between effort an F is much more linear for a situation where cod is caught in a bycatch fishery in the Irish Sea. This is also shown for North Sea cod over 2003-2009 (Figure 5.1, cf Annex 12), where the trends in F are better correlated to the trends in effort of gears catching cod as a by-catch (*Nephrops* trawl TR2 and beam trawls) than to the trends in cod-targeted TR1 and for GN1 where the correlation is apparently good but with little change in effort. Thus effort may regulate bycatch but may have less impact on directed fisheries which can change behaviour to mitigate the effort regulation.

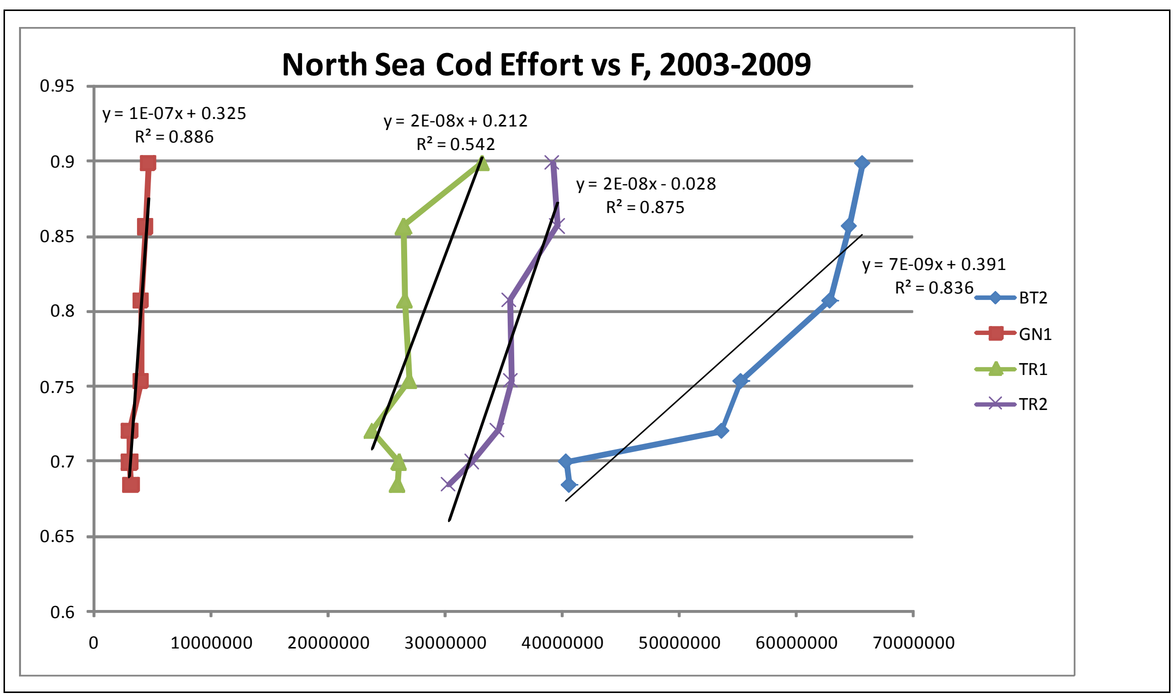


**Figure 5.1.** North Sea cod. Correlation between estimated Fbar (assessment 2011) and EC effort by main gear category, 2003-2009 based on the 2011 assessment.

# 6. EVALUATION OF THE EFFECTS OF THE MULTI-ANNUAL PLAN ON THE FISHERY

Data on catches, landings and effort were assembled at the STECF EWG 06-11 Effort group. The results are preliminary but are thought to be substantively correct for most countries except possibly France. Data on landings and effort in Norwegian trawl fisheries from the North Sea 2003-2010 were submitted during the meeting. The format is as submitted to the ICES WGMIXFISH. The Norwegian trawl fisheries in the North Sea are mainly targeting saithe.

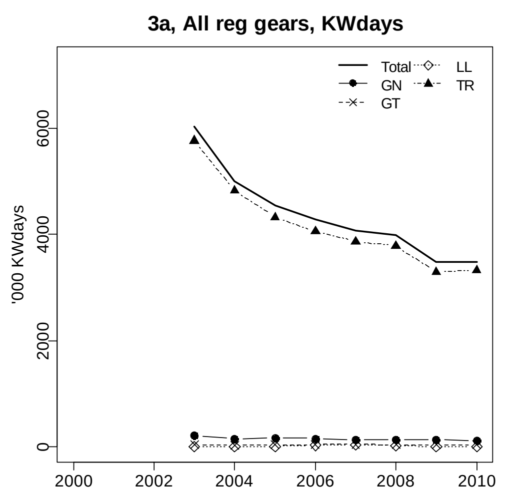
## 6.1. Changes in effort for managed units

Updated information on effort (kWdays) and catches (tonnes) by fleets operating under the cod plan was available from STECF EWG - 06 -11 held earlier in June 2011. Results are preliminary and had not been reviewed by STECF at the time of this meeting (EWG 07-11). Most countries submitted data for 2010 according to the formal EU data call (Ref. Ares(2011)200418 - 23/02/2011) but there were no data supplied by Spain. In the context of the cod plan discussions, this shortfall mainly affects ICES area VIa (cod plan area 3d). A few revisions to the available data are expected prior to the second effort meeting, but for the purpose of drawing broad conclusions with respect to the cod plan these preliminary data are considered adequate.

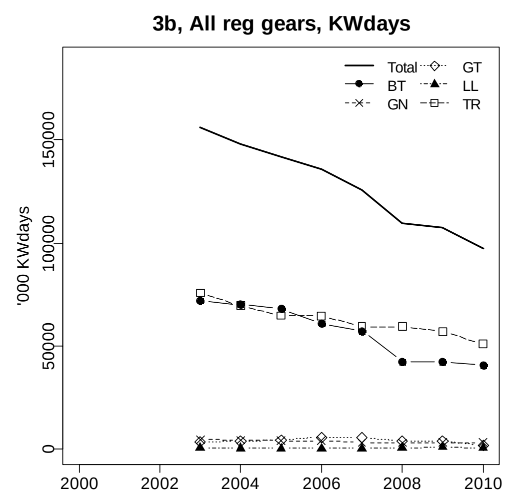
This section describes broad trends in overall regulated gear effort followed by comments on predominant gears used in the different areas of the cod plan and a consideration of the scale of use of unregulated gears and the use of provisions in the cod plan (e.g. Articles 11 and 13). A similar summary of catches is also provided. Detailed information supporting the comments in this section can be found in the tables of Annex 7.

Figure 6.1 (below) shows the overall trends in effort by the main regulated gear types in the four areas covered by the cod plan. Data are available from 2000 but plotted from 2003 only owing to an unresolved problem with French effort data for 2002. In all areas there have been marked reductions in overall effort, particularly in the early part of the series before the existing cod plan came into force. The declines arise from major decommissioning schemes and the previous cod plan. In most areas, recorded effort levelled off during the first years of the current plan. Trawling is by far the predominant activity in Kattegat, Irish Sea and West of Scotland while in the North Sea beam trawling is of comparable importance. The importance of specific regulated gear categories varies between the areas, with TR2 trawl gear (mesh size <100mm) being most important in the Kattegat and Irish Sea, TR1 gear (mesh size >100mm) being most important in the West of Scotland and BT2 beam trawl gear being the most important single gear in the North Sea (only the combined TR1 and TR2 exceeded this). There is no evidence of the use of any regulated gear types increasing significantly in the cod plan areas.

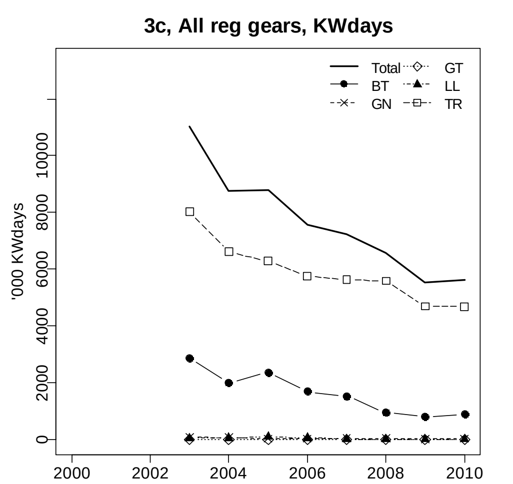
The proportion of the recorded all-gear total effort attributable to unregulated gears varied considerably between the areas. The lowest values (6-18%) were obtained in the Kattegat and mostly recorded by otter and pelagic trawls. Intermediate values were observed in the North Sea and Irish Sea (23-31% and 18-37% respectively) mainly by beam, pelagic and otter trawls in the former and dredges in the latter. Highest values (41-53%) were recorded in the West of Scotland where pelagic trawls and pots were the most prominent gears.



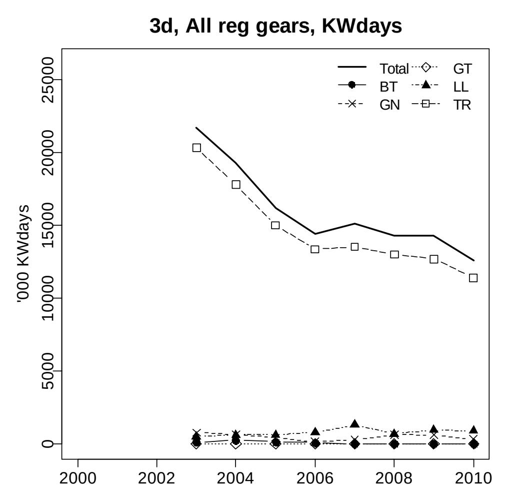

3a Kattegat




3b North Sea




3c Irish Sea




3d West of Scotland

**Figure 6.1** Trends in effort (kWdays) for the main regulated gear types operating under the cod plan in Kattagat, North Sea, Irish Sea and West of Scotland. Data presented for 2003-2010.

Effort attributable to vessels operating under Article 11 (<1.5% cod in catches) generally represented a low percentage of total regulated effort (less than 3% in the Irish Sea and North Sea and 8% in the West of Scotland). The highest percentage (14%) was recorded in the Kattegat where a significant proportion of the TR2 trawl fleet operates using the Swedish grid.

Effort attributable to vessels operating under Article 13 (highly selective gears, <5% cod and cod avoidance measures) represented a variable proportion of the total regulated effort depending on area. The lowest value (about 25%) was recorded in the North Sea and the highest (close to 70%) in the Kattegat. The variation depended on the numbers of gears and countries operating in each area and the extent to which application for the use of Article 13 was made for prominent gear types (e.g. TR2 in the Kattegat).

Effort recorded for fully documented fisheries (FDF) was generally low except in the North Sea, where Denmark and the UK have been trialling the use of Remote Electronic Monitoring (REM) technologies in pilot catch quota schemes.

## 6.2. Changes in cod catch for managed units

Overall catches by regulated gear and the patterns of discarding through time show different trends in the different areas (Figure 6.2). In the Kattegat, catches (mainly by TR2 gear) have declined to less than one tenth of the amount in 2003. Discard rates by the main gear appear to be variable (32 -53% with no obvious trend). North Sea catches (mainly by TR1 gear) rose until 2008 reflecting improved recruitment from the 2005 year class. Catches have since shown a small decline. Discard rates by TR1 in the North Sea rose to 53% in 2008 but have since shown a marked fall to 20% in 2010. In the Irish Sea, stable catches (mainly by TR1 and TR2 gears) between 2003 and 2008 have been followed by two years of lower values. Here the estimated trawl discard rate is very erratic and there is uncertainty about their reliability. In the West of Scotland, catches have fluctuated without any trend over the time period and remain high despite progressive reduction in TAC. The predominant cod catching gear is TR1 and the discard rate for this has risen steadily to over 80% in 2010.

The catches made by unregulated gears generally represent a low percentage of the overall regulated gear catch of cod (below 4% in most cases). There remains some uncertainty about the extent to which the available figures for all of the different unregulated gears contain estimates of discards and this will be considered further by the STECF effort management group. Where such estimates are available, however, they generally indicate that discarded quantities are relatively small and appear to confirm that catches from the unregulated gears are not a significant problem in the areas covered by the cod plan.

In all the areas where Article 11 exemptions have been applied, catches of cod by vessels under Article 11 represent a small proportion of overall cod catch made by regulated gears (5% or less).

In the different areas, catches of cod by vessels utilising the Article 13 provision vary between about 45% and 75% of the overall catch made by regulated gears (Figure 6.2). Highest percentages occur in areas where a significant proportion of the fleet operates under Article 13 (for example the Kattegat) and are not to be unexpected. Evaluation of the impact of Article 13 requires more detailed analysis than consideration of catch proportions alone. The provisions of Article 13 are intended to bring cod catches in line with what is implied by the forecast consistent with the cod plan HCR and to reduce unwanted catches (leading to discards) which exceed the target. This is discussed further in Section 5.4.4

Information on catches by fully documented fisheries (FDF) was also available, but are likely to be revised before the second STECF effort management meeting, and at this stage are only indicative of the scale of catches.

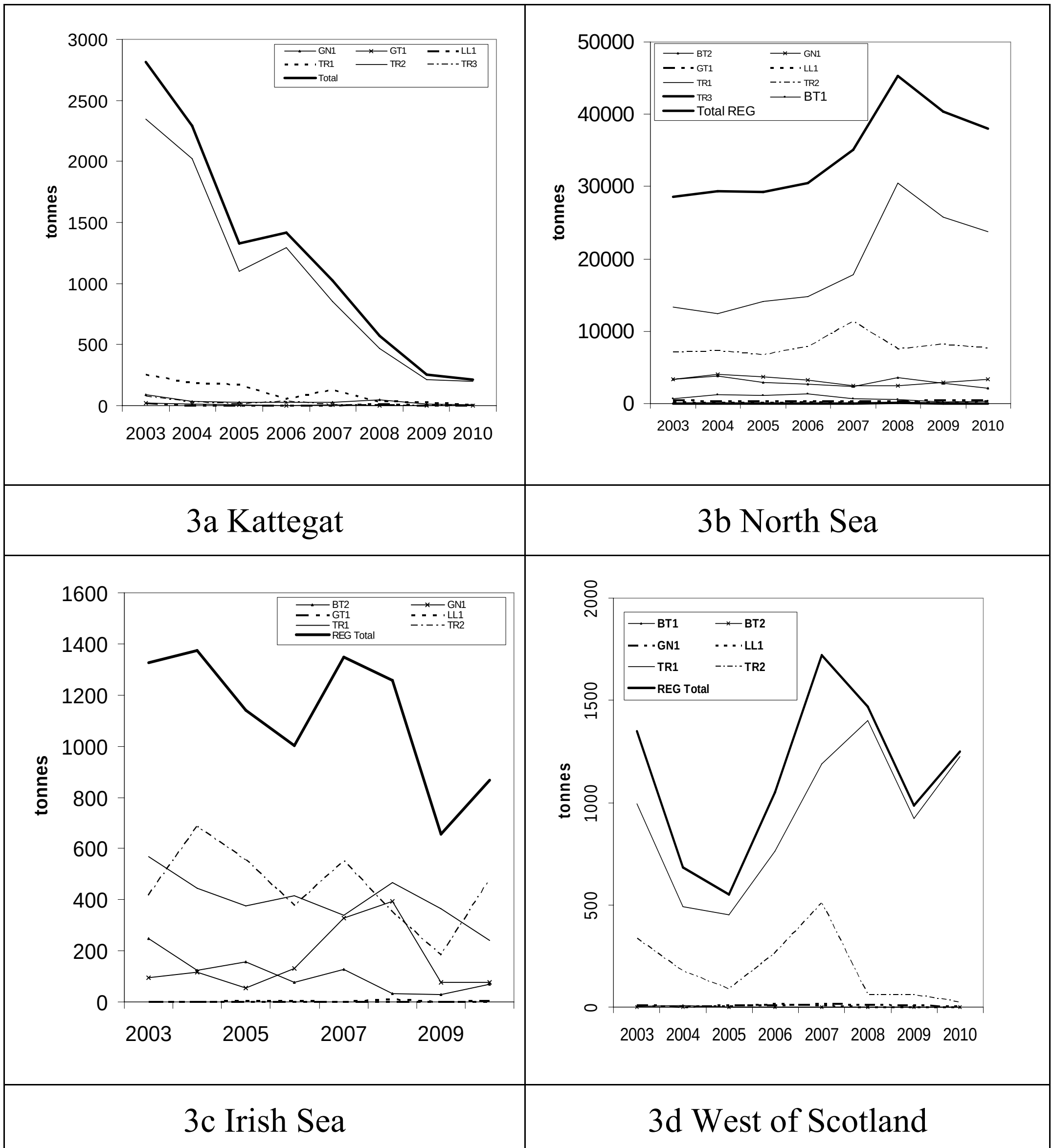



**Figure 6.2** Trends in catch (landings +discards - tonnes) for the main regulated gear types operating under the cod plan in Kattegat, North Sea, Irish Sea and West of Scotland. Data presented for 2003-2010

## 6.3. Catch curve analysis

The objective of a catch curve analysis was to examine if trends in mortality can be detected in catch, in the absence of a full analytical stock assessment. A preliminary evaluation of the use of the catch at age data (landings and discards) for the main gears identified was carried out; the results were rather inconclusive suggesting the individual fisheries do not contain substantive information to inform on mortality in the absence of an assessment.

## 6.4. Presentation of VMS information

The recent development of satellite tracking and global position systems has made it possible to study the spatiotemporal distribution of deployed fishing effort at a higher resolution than before through the use of VMS (Vessel Monitoring System) information. In a few cases VMS has been used to indirectly assess local concentrations of fish (e.g. Poos and Rijnsdorp 2007). In several studies, VMS data have been used together with official logbook data in order to estimate fishing mortality for non-target species (Piet et al 2009); to calculate the fishing mortality imposed on a stock by single fishing operations (Rijnsdorp et al 2006); or to explore the spatial distribution of catch and effort at high spatiotemporal resolution (Bastardie et al 2010, Gerritsen and Lordan 2011). Such data will be also an important element to evaluate the effectiveness of long term management plan (LTMP) where effort regulation is an important component of the plan itself. Moreover, the reform of the European Common Fisheries Policy should result in an Area Based Management integrated on the Ecosystem Approach and in this context VMS will play an important role to achieve this.

Kattegat VMS

VMS records from fishing vessels of both the Swedish and the Danish TR1 and TR2 segment that catch cod in the Kattegat were collated for the period 2007-2010 (Morten et al. WD Annex 8). Swedish VMS data includes also information on the application of the “Swedish sorting grid”. For the use of the SELTRA 300 trawl, no information in the electronic version of the logbook data about the actual use of that gear is available. The VMS data classified as “fishing” for the Danish and Swedish TR1 and TR2 segment for the period 2007-2010 were selected using speed criteria. The VMS data show that the main part of the Danish and Swedish fisheries takes place on shared fishing ground in the eastern and deeper part of Kattegat; however, the Danish fishery extends more easterly and southerly than the Swedish. Closed areas for protection of cod were established in 2009 in Kattegat. Sweden had almost no activity in the permanent closed (“the red area”) area in Kattegat and in the Sound (“Kilen”; “the black area”; temporary closure in the spawning season except for fishery with selective gears with a very low catch of cod) before the closure in 2009. The “orange” area is closed for bottom trawling during the spawning season and all year for all fisheries except fisheries with selective gears with a low catch of cod, e.g. sorting grid.

The effect of the box closures in 2009 is clearly seen for the effort distribution estimated using the VMS in the first quarter. Effort seems redistributed more westerly after the closure. For the second quarter, effort in the “red” area (closed for all commercial fisheries) was close to zero in 2009, but with some activities in 2010. Generally, the effort in the “orange” area (closed for all fisheries except fisheries with selective gears with very low catch of cod, i.e. Swedish grid or SELTRA 300) has increased significantly in 2010 and it seems to be the most important area in the second quarter. Based on the calculated centre of gravity of the fishing effort by year and quarter, the large scale changes in effort distribution since 2007 have been rather modest. The same conclusion about a stable fishing pattern can be derived from the fished area by year and month.

In conclusion, the introduction of closed Kattegat areas in 2009 had, as intended, given a very low effort in the affected areas in the first quarter of 2009 and 2010. Total annual effort estimated by VMS records seems, however, to have been stable (2009) or increased (2010) since the closure. For both years, quarter 1 effort was reallocated outside the closed areas, mainly to the more eastern grounds. This pattern changed significantly in 2010 where the closed area had the highest concentration of effort in the entire time series (2007-2010), which might be linked to a higher CPUE of especially larger *Nephrops* in the area due to the area closure the year before. As cod selective gears are mandatory in the area, a shift to such gears will decrease the fishing impact (discards) on cod significantly, even though the concentration of cod is relatively high in the area. The closure of the northern Sound (“Kilen”) has almost entirely removed effort by segment TR1 and TR2 in the area.

Scottish VMS

The UK authorities have provided maps that show spatial fishing effort (VMS) linked to logbook data for six species (cod, haddock, whiting, megrim, monkfish and saithe) for UK vessels only fishing along the shelf break (STEFC 2010). The data presented provides information on the spatial exploitation pattern. This can not be interpreted as the distribution of the individual species, only the distribution of the retained catch. Cod is caught in all areas with significant landings from inside the line to the north and north-west of Lewis and to the west of the Orkney Islands. Catches are generally associated with the northern part of VIa along the shelf break. In addition, significant landings are also taken in waters deeper than 200m, particularly in the depth band of 200 to 300m, with the VMS and landings data indicating some minor cod catches in depths greater than 300m.

### Irish VMS

A VMS dataset of effort (i.e. hours fished) for 2006-2010 was collated for the Irish fleet for area VIa and VIIa (Kraak WD Annex 9). The effort was estimated for the three main métiers (TR1, TR2, and BT2) catching cod and using only the first three quarters as the data for the last quarter for 2010 was not available. The amount of effort deployed was estimated in grid cells with zero, low (0-5 kg/h), medium (5-10 kg/h), or high (>10 kg/h) observer cpue levels of cod. Data was merged for VIa and VIIa but the analysis could be done for the separate regions. An increase in effort in the medium- and high-abundance cell-week combinations was observed in 2010. When the fishing hours are treated separately for the 3 gear groups TR1, TR2, and BT2, the same trend has been observed. The conclusion is that in 2009 and 2010 a reduction of fishing activity in areas with high cod abundance compared to 2008 was not observed, countering the objective of the plan.

### Conclusions to VMS studies

It is generally recognized that the use of official effort and landings data does not allow to distinguish between fishing and steaming time, or to account for the discarded part of the catch, introducing an important bias in the study of the fishing effort-fishing mortality relationship. Integrating VMS information with landings data and catch data through observers or camera systems will provide more robust information on effective effort (i.e. trawling time) and cpue, and analysis of integrated VMS and logbook data will allow fisheries data to be analysed on a considerably finer spatial scale than was possible previously (Bastardie et al 2010, Gerritsen and Lordan 2011). The analysis of the Kattegat, Irish and Scottish data has shown how VMS data can be used for evaluating fisheries management actions, such as the implementation of closed areas and fleet-specific effort regulations for a particular fishery, and evaluates the effectiveness of effort restrictions within a management plan.

## 6.5. Evaluation of the effects of the multi-annual plan on the stock

Evaluation of the stock, exploitation (F) and the degree of compliance and effectiveness of certain regulations all can in principle be determined *post hoc* if accurate estimates of (relative) fishing mortality rate are available, usually from stock assessments. However, stock assessments may suffer from too much noise, too much smoothing, and/or retrospective bias (Dickey-Collas et al. 2007, Kraak et al., 2008, Kelly et al., 2006). These are the result of intrinsic difficulties in the stock assessment process and can be summarised as ‘deciding on the correct amount of smoothing’ to minimise the effect of noise and reduce the bias and bring out the most informative ‘signal’ in terms of SSB or F. Choosing this level of smoothing is not a trivial decision. Due to these difficulties for most of these stocks (Irish Sea, Kattegat, West of Scotland) analytical stock assessments were not agreed by ICES and a short term forecast (STF) giving catch advice was not provided. Nevertheless, in all cases the SSB was estimated. In all cases, except the NS, lack of a well-estimated F in the last year makes it difficult to evaluate how effective the measures have been in achieving the plan’s aim; it may be that this can be assessed well only several years after the measures were set. The following sections use the stock assessment, where available, to evaluate the state of stock and its exploitation.

### *6.5.1. Kattegat Cod*

The SSB of cod in the Kattegat steadily declined from around 35 000 tons in the late 1970s to 5000 tons in the end of the 1990s (Figure 6.3). Since 2000, the SSB is estimated to be below Blim (6000 tons). The assessment for the latest years suffers from uncertainties, caused by significant unallocated removals (UR), estimated based on survey information.

The benchmark assessment workgroup in 2009 (WKROUND 2009) concluded that the results from runs with and without estimating UR should both be considered as final assessments (ICES WGBFAS 2011). This is because the contributions of fisheries- and biology-driven factors (migration patterns) to the estimated unallocated removals could not be specified. Concerning the SSB, both assessments (with and without UR) estimate the SSB in 2010 at around 1000 tons, which is in line with fisheries-independent survey-based biomass estimates (ICES WGBFAS 2011). The estimate for 2011 indicates a slight increase compared to 2010. Recruitment in recent years has been among the lowest in the time series. The recent survey data indicate the 2010 year-class to be somewhat stronger compared to two previous ones but still rather low. The analyses of potential environmental effects on recruitment concluded that the current low level of recruitment is mainly due to low level of SSB, rather than due to any external factors (Annex 10).

Current level of fishing mortality is unknown and is likely in between the two estimates from the runs with and without estimating the UR. Under the assumption of no unallocated removals, F in 2010 (0.1) is estimated to be well below the target of the plan (0.4) and F decreased by 50% since 2008 and by 84% since 2004. Officially reported landings decreased substantially (Figure 6.3) and the reported landings of cod in the Kattegat in 2010 were 155 tons, while the TAC was 379 tons. Taking unallocated removals into account leads to an F at 1.1 in 2010 with only a marginal decrease in F since 2008 (2%) and an increase since 2004 (8%). The scaling factor for the estimation of unallocated removals increased from 1.61 in 2003 to 8.28 in 2010 (ICES WGBFAS 2011).

To disentangle recent changes in fisheries-induced mortality on Kattegat cod, two sets of analyses were conducted:

- The fishing impact (proxy for fishing mortality) on cod in Kattegat from the TR2 segment was estimated based on temporal and spatial distribution of the cod stock and the fishery (see Annex 8 for details).

- Available information on different sources of catch was combined to evaluate whether the estimated total removals could possibly be related to fisheries (see Annex 11 for details).

The results from the analyses (i) lead to the conclusion that the fishing impact on cod in Kattegat from the TR2 segment has decreased in the period 2007-2010 for all age-groups of cod. The fishing impact in 2010 is estimated to be around 63% of the impact in 2007, which is equivalent to an annual decrease of around 14%. Nominal effort measured as kW-days has remained at the same level since 2007, so the decrease in fishing impact is due to a combination of closed areas which exclude the fishery from areas of high cod densities, and the application of selective gears. The reduction in fishing impact was highest in 2009 due to the introduction of closed areas. In 2010, effort increased again in these areas, and the estimated reduction in fishing impact was due to application of selective gears, required for access to the closed areas. The decrease in fishing impact in 2010 was smaller than estimated for 2009, and sensitive to the catchability value applied for selective gears (Annex 8).

In the analyses (ii), the information on commercial landings, discards and recreational catches of Kattegat cod were combined and compared with estimated total removals from the stock. The results showed that the available data on fisheries catch cannot explain the discrepancy between the landings and estimated total removals from the stock. Even though the available information on discards and recreational fishery indicated that the total fisheries catch in 2010 was about 3 times higher than the landings, this estimate of total fisheries catch is still more than 50% lower than the estimated total removals from the stock (Annex 11).

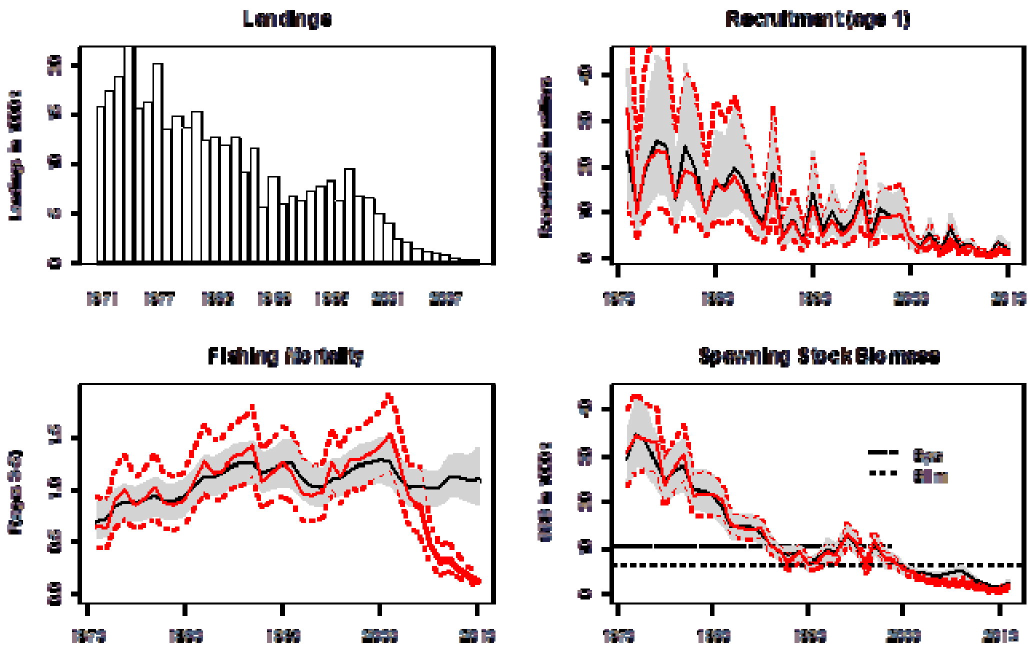



**Figure 6.3**: Summary of cod in the Kattegat stock assessment (weights in '000 tonnes) represented by two runs with (black line) and without (red line) estimating unallocated removals. Shaded area and broken lines represent 95% confidence intervals for the runs with and without estimating unallocated removals, respectively. (ICES WGBFAS 2011)

### *6.5.2. North Sea Cod*

An analytical assessment of this stock was carried out in 2011 (ICES WGNSSK 2011). This assessment estimates the historic stock abundance and fishing mortality including the uncertainty about these estimates given the data. The median estimates of the stock development are used in the analyses below. The uncertainty around these values should be taken into account. According to the 2011 assessment, fishing mortality declined since 2000, but it is estimated to be well above the level that achieves the long-term objective of maximum yield (0.19) and the target of the current management plan (0.4; Figure 6.4). The fishing mortality in 2010 (0.68) is estimated to be above Fpa (0.6) and to be 20% lower than F in 2004 but only 3% lower than F in 2008. The WG indicate that the estimate for F in 2010 might be overestimated as the 2011 assessment showed a slight retrospective pattern overestimating F in the most recent years (ICES WGNSSK 2011) but there is no indication that the bias is large. SSB has increased since its historical low in 2006 (29437 t), but remains (54721 t) below Blim (70000 t; Figure 6.4). SSB increased by 86% since 2006 and by 29% since 2008. Recruitment since 2000 is poor and without obvious trend (Figure 6.4). The 2005 and 2009 year classes are slightly stronger but still well below historically observed recruitments.

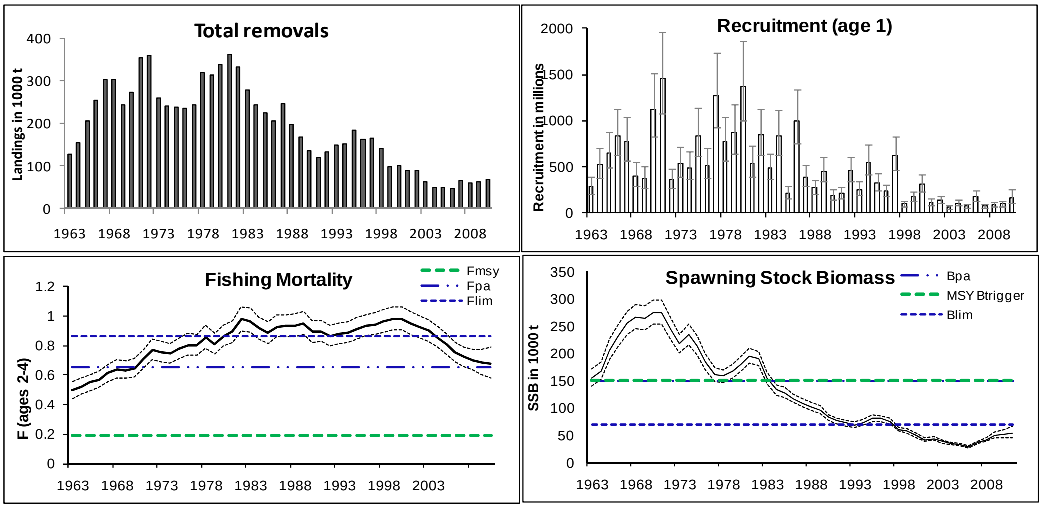



**Figure 6.4:** Cod in Subarea IV (North Sea), Division VIId (Eastern Channel), and IIIa West (Skagerrak). Summary of stock assessment with point-wise 95% confidence intervals, catch estimated, and adjusted for unallocated removals (from 1993), weights in tonnes.

### *6.5.3. Irish Sea Cod*

According to the latest assessment (ICES WGCSE 2011), the spawning-stock biomass has declined ten-fold since the late 1980s and is suffering reduced reproductive capacity (SSB < Blim of 6000 t; Figure 6.5). The 2010 SSB was the lowest on record (947 t). SSB has declined by 77% between 2004 and 2010 and by 45% since 2008. The 2011 SSB is estimated to increase to 2260 t (calculated from survivor point estimates). Independent estimates of SSB using the Annual Egg Production Method (AEPM) give SSB estimates for cod well above the absolute values given by the assessment. The relative trends in cod SSB from the AEPM and the assessment are more consistent than the absolute values and both indicate very low SSB in 2010. The AEPM estimates for cod remain well below the ICES assessment estimates for the 1970s-1980s, when catch-based estimates of SSB averaged 14kt, and are also below the limit biomass reference point (Blim) of 6kt for Irish Sea cod. All sources of fishery and survey data indicate a very steep age profile indicating high rates of mortality in Irish Sea cod.

The fishing mortality estimates (including unallocated removals) since 1988 have remained above the Flim value of F=1.0 and the stock has therefore been harvested unsustainably during this period to 2010 (Figure 6.5). There is an increase estimated for F 2009 relative to F2008 (+ 9%), but a reduction for F 2010 (-14%). However, unallocated removals play an important role in this assessment and it is not entirely clear whether unallocated mortality can be attributed only to fishing mortality. Also unknown sources of natural mortality may cause part of the perception of fishing mortality trends.

Recruitment has been below average for the past eighteen years. The 2002 to 2008 year classes are amongst the smallest on record. Data show increased recruitment in 2009 compared the recent period of poor recruitment, but still below the long-term average. Preliminary indications suggest the 2010 year class is below the 2009 estimate. The increased recruitment in the last two years may lead to an increase in SSB in the next years from the historical low.

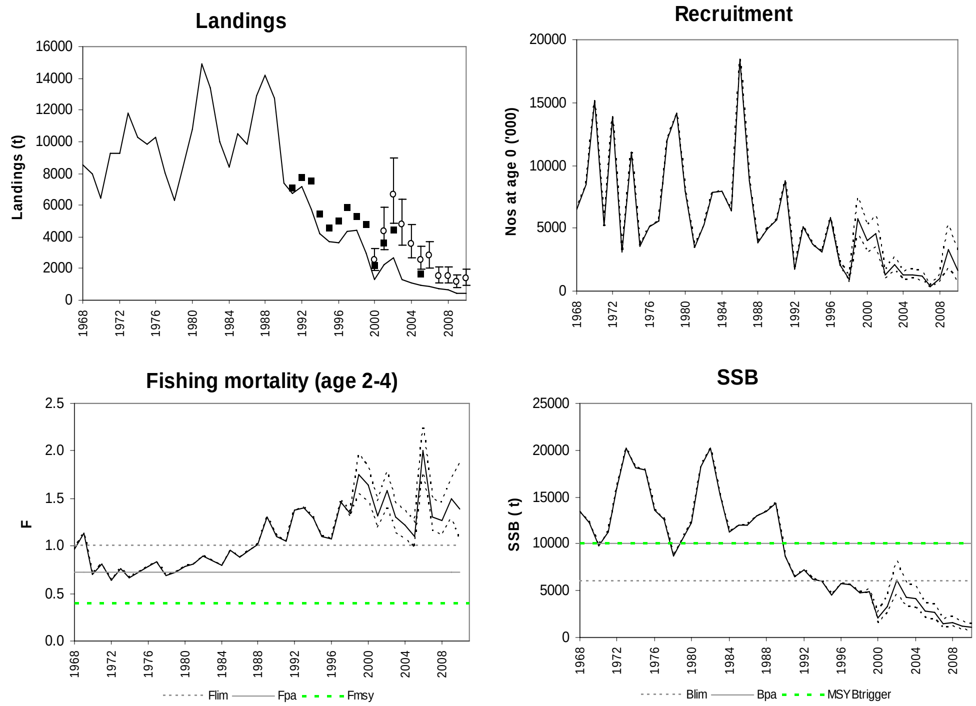



**Figure 6.5:** Cod in Division VIIa (Irish Sea). Summary of stock assessment (weights in '000 tonnes) Landings plot: solid line are reported landings; filled squares are landings incorporating sample-based estimates at three ports; circles are total removals estimates in excess of M=0.2 with 90% confidence intervals from B-Adapt. Recruitment, fishing mortality and SSB: solid lines are median values and dotted lines are $5^{th}$ and $95^{th}$ bootstrap percentiles. (ICES WGCSE 2011)

### *6.5.4. West of Scotland Cod*

An analytical assessment was carried out in 2011 (ICES WGCSE 2011) but this has been rejected as the basis for advice by ICES because it relied on data from a research survey which changed ground gear and statistical design in 2011. The following statements are based on the median values of the estimates from the 2010 ICES accepted assessment (ICES WGCSE 2010). It has to be taken into account that there is uncertainty around these values. It is considered that natural mortality is probably above the constant of 0.2 on all ages, assumed in gadoid stock assessments for WoS, and with a trend, but the levels have not been quantified. As a consequence it is not considered possible to partition mortality into fishing, discard and unaccounted mortality. Instead assessment results are simply described as total mortality minus the input 0.2 for natural mortality, or 'Z-0.2'. Because the assumption for natural mortality M has remained the same since the determination of F reference points, values of Z-0.2 can be considered in comparison to those reference points, but this comparison does assume any trend in M is small. According to the 2010 assessment, Z-0.2 mortality has, since the mid 1980s fluctuated around a level just above Flim. Because catch data are not used from 1995 onward (concerns over under-reporting), the estimate is very uncertain. However, even the lower bound of the 95% confidence limit is higher than Fpa and well above the level that achieves the long-term objective of maximum yield (0.19) and the target of the current management plan (0.4; Figure 6.6).

Z-0.2 in 2009 (0.87) was estimated to be 6.5% lower than Z-0.2 in 2004 and 4.4% lower than Z-0.2 in 2008. The lowest estimated value of Z-0.2 since 2004, however, was for 2007 and the value of this metric has no clear trend over the period.

SSB has increased since its historical low in 2006 (3573 t), but remained below Blim (14000 t) in 2010 at 6227 t; (Figure 6.6). SSB increased by 74% since 2006 but was estimated to have fallen by 5.4% from 2008 to 2010. An increase from the 2008 value to the projected 2011 value of 16% was predicted. Recruitment since 2000 is poor with no obvious trend. The 2005 and 2008 year classes are stronger than the norm over the last decade but still well below historically observed recruitments (Figure 6.6).

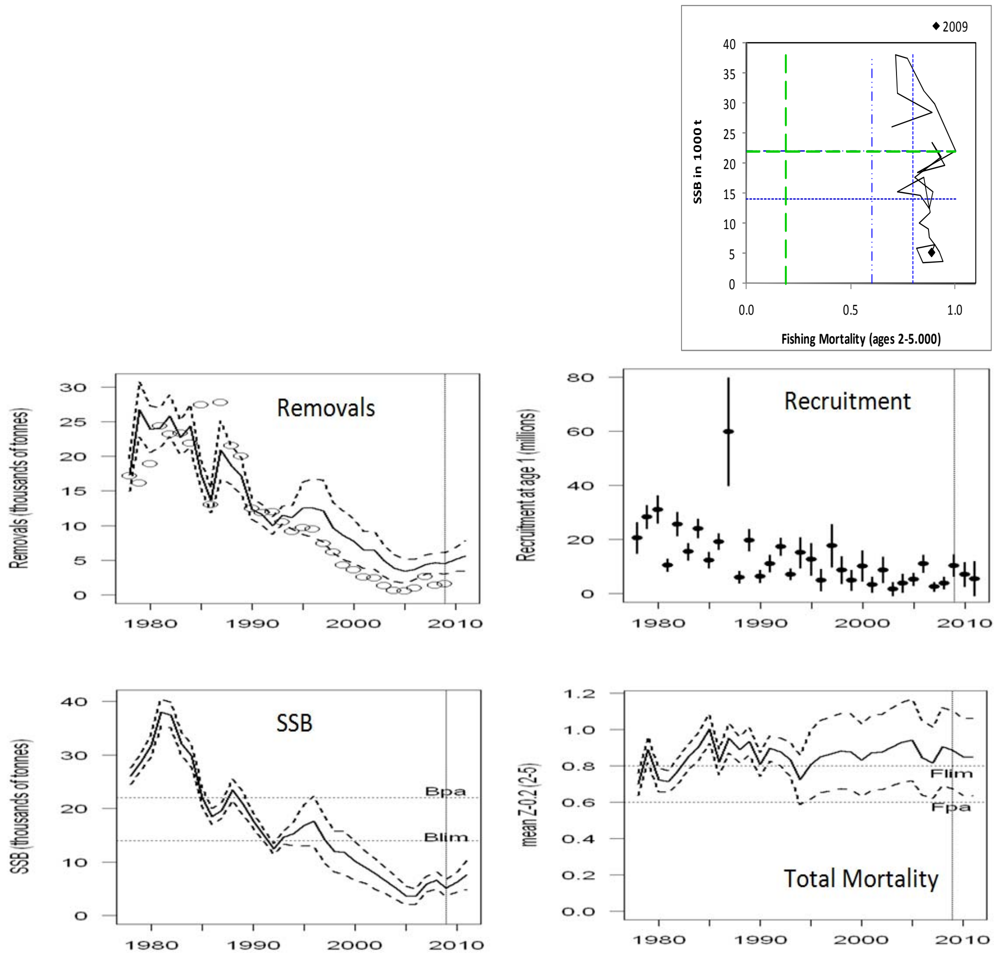



**Figure 6.6**: Cod in Division VIa (West of Scotland). Summary of stock assessment – 2010 assessment - (weights in '000 tonnes). Removals: open circles = observed catches, lines = estimated removals. Estimates are plotted with approximate point-wise 95% confidence bounds. The vertical line in each plot delineates the last year of the historical assessment (2009); estimates to the right of these lines are forecasts. ICES WGCSE 2010

## 6.6. Evaluating if objectives are achieved

### *6.6.1. Kattegat Cod*

Whether the objectives of the plan in terms of reductions in fishing mortality are met cannot be answered due to the uncertainties introduced by unallocated removals. However, SSB is in any case still well below Blim and recruitment is still very low.

### *6.6.2. North Sea Cod*

Downward trends in fishing mortality and upward trends in SSB started during the implementation of the previous cod plan (2004-2008) and continued after the new management plan was implemented. Recruitment is still very low. The reductions in F in 2009 and 2010 are marginal and are statistically not significant given the uncertainty around the point estimates (Figure 6.4). The reduction in F since 2008 is less than the intended reduction in the plan (intended F2009= 75% of F2008; intended F2010=65% of F2008). The WG indicates that the estimate for F in 2010 might be slightly overestimated as the 2011 assessment showed a slight retrospective pattern overestimating F in the most recent years (ICES WGNSSK 2011). However, this is unlikely to change the overall conclusion that F has not declined in line with the plan.

### *6.6.3. Irish Sea Cod*

Whether the objectives of the plan in terms of reductions in fishing mortality are met cannot be answered due to the uncertainties in the source of unallocated removals. However, SSB is in any case still well below Blim. There are positive signs for increased recruitment driven by environmental factors which may lead to an increase in the stock in the next years.

### *6.6.4. West of Scotland Cod*

It is not possible to answer whether the objectives of the plan in terms of reductions in fishing mortality are met because of uncertainties introduced by unallocated removals. In the case of WoS cod the concerns about unallocated removals revolve around a suspected high level and trend in natural mortality as much as unallocated removals due to fishing. However, as pointed out by the ICES assessment, for management purposes the estimated Z-0.2 mortality would still need to fall below the level of Flim, as higher levels of mortality over and above M are considered to have led to stock decline. SSB is still below Blim and there was a decrease between 2008 and 2010 although SSB increased between 2006 and 2008.

## 6.7. Evaluation of reasons for deviation

In order to elucidate the source of the deviations from the plan, several analyses were carried out for the four stocks:

- Estimation of the difference between the TAC advice according to the plan based on the historic assessments and forecasts and the actual TAC decided by the council. It was elucidated what the TAC decided by the council implies in terms of predicted F and SSB developments according to the short term forecasts used as basis for advice and final decisions. For this purpose we analysed ICES advice option tables and STECF reviews of ICES advice. If the TAC was in between two options in the ICES management table presented, a linear interpolation was used.

- Analysis on whether the catches were limited by the TAC (which under current procedures only limits landings). To this end it was analysed how the proportionality between the different sources in the catch (discards, landings, and unaccounted removals) changed over time.

- Analysis on whether assumptions and results from the short term forecast on which the advice was based were consistent in retrospect or whether they have contributed to the deviations from the planned exploitation (possible for North Sea cod only).

### *6.7.1. Kattegat Cod*

The agreed TACs have been in accordance with Article 9a of the management plan since the implementation of the plan in 2009. In the absence of reliable forecasts the TAC was reduced by 25% in 2009 and 2010 (see Annex 12 Table 1). In 2011 the TAC was reduced more than required by the plan (-50%) but as suggested by the Commission policy paper from 2010 (EC 2010). The agreed TACs, however, were above ICES biological advice. ICES advice was in all three years based on the precautionary approach only and aimed for zero catch (no directed fishery in 2011). ICES states that a TAC constraint alone (under Article 9) is not precautionary for this stock. STECF agreed with ICES advice for 2009, 2010 and 2011, but additionally notes that the TACs based on the management plan should be 379 tons in 2010 and 284 tons in 2011 (see Annex 12 Table 1). STECF questions the ICES point of view regarding the precautionary nature of the plan by noting that under article 12 of the management plan fishing effort is adjusted by the same percentage as the TAC. In the years between 2004 and the implementation of the plan, ICES and STECF advice was always zero catch based on the precautionary approach. Since no short term forecasts were conducted after 2004, no implied changes in F and SSB according to short term forecasts were analysed.

Total removals (landings * scaling factor) estimated by the stock assessment with unallocated removals decreased over time (see Annex 12 Figure 2). Total removals decreased since 2008 but there is a slight increase between 2009 and 2010. The proportion of landings in total removals declined substantially over the last years, i.e. further declined since 2008 (see Annex 12 Figure 3). In 2010 landings were only responsible for 12% of estimated total removals. Therefore, the TAC alone cannot restrict removals from the stock according to the assessment with unallocated removals. The proportion of the fisheries (discard, high grading, and black landings) and biological (migration, natural mortality) factors cannot be specified making unallocated removals to a black box and a serious problem for achieving objectives of the management plan.

### *6.7.2. North Sea Cod*

In the years before the implementation of the current management plan, ICES advice was based on the precautionary approach since ICES concluded that the old cod recovery plan (EU 2004) was not consistent with the precautionary approach. The plan did not include an adaptive element implying that fisheries for cod remain closed until an initial recovery of the cod SSB has been proven. Therefore, the agreed TACs 2004-2007 were always above ICES advice, but in line with STECF advice in 2008 (Table 6.7.1). The estimation of implied changes in F and SSB from the short term forecasts was not straightforward for these years. Before 2007 no short term forecast was presented in the advice. Only total removals were presented in the forecasts for 2007 and 2008 TAC advice, but not landings, discards and unallocated removals separately, although the recent three-year-average split was given as a footnote. Under the assumption that future proportions of landings, discards and unallocated removals are the same as this recent average, the TACs would imply strong reductions in F and substantially increased SSB (Table 6.7.1). However, ICES states in those years that future proportions would be difficult to predict.

For 2009 ICES and STECF advice was superseded since the management plan was agreed in December of 2008 after the advice was published. However, it was stated in the 2009 ICES Advice that unallocated removals were no longer considered significant for the North Sea cod. Therefore, the final TAC decision in 2009 was most likely based on the rationale that the target F of the management plan (0.4) would be reached in 2009 as predicted in the short term forecast carried out in 2008 (Table 6.7.1) and that there are no unallocated removals during the TAC year. This implied an increase in TAC above the TAC constraint of the old (15%) and new (20%) cod plan, at the same time it was argued that the increase would reduce discards. Therefore, the inter-annual constraint on change in TAC was suspended in 2009 under the move to the new management plan (Article 8 (5)).

For the years 2010 and 2011 the TAC was set in a way that F was predicted to decrease at least as intended by the management plan (25% in 2009 and 10% from F 2008 estimated at that time thereafter) and SSB was predicted to increase above Blim during the TAC year for 2009 to 2011 (Table 6.7.1). However, it was stated by ICES in the 2009 and 2010 advice that this would only be valid under the assumption that the management plan is implemented and enforced adequately and that objectives of the plan during the intermediate year are met (ICES Advice 2009, ICES Advice 2010). Although ICES describes in the advice that this was unlikely to be achieved, the TACs for 2010 and 2011 were set under the assumption that objectives were met for the intermediate year (i.e. reduction in F during the intermediate year) and that there are no unallocated removals during the TAC year. Both assumptions turned out to be inappropriate according to the latest assessment and this procedure is considered to have contributed to the objectives of the plan not being met, though it is unknown if changing the procedure and setting TACs lower would have made any substantive difference to catches/removals.

The total removals of cod in the North Sea are estimated in terms of (i) landings, (ii) discard and (iii) unallocated removals. The proportions of landings, discard and unallocated removals in total removals changed considerably over the last 10 years according to the latest assessment estimates (ICES WGNSSK 2011; see Annex 12 Figure 5 and Table 3). The proportion of landings in total removals decreased substantially between 2000 and 2007. In 2007 landings were responsible for 35% of total removals. In the last three years the proportion of landings increased and reached 56% in 2010. The proportion of discard was less than 17% between 2001 and 2006, but increased to above 30% in 2007 and 2008. In 2009 and 2010 the proportion of discard decreased again and is estimated to be around 21% in 2010. This reduction coincides with the implementation of the management plan in 2009 but also with the larger 2005 year class losing its importance in catches. It has to be proofed when another larger year class enters the fishery whether this reduction in discards is sustainable. Unallocated removals comprise an important part in total removals from the stock. Its proportion peaked in 2003 (47%) and decreased afterwards. Since 2009, however, the proportion is stable at around 23%. Despite a first success in reducing the proportion of discard and unallocated removals, the TAC alone is not able to restrict total removals and this hinders the achievement of objectives, especially if unallocated removals are not included in the procedure for setting the TACs.

A hind-casting exercise was conducted to investigate the performance of the short term forecasts in predicting the future response of the stock to a given fishing mortality (details see Annex 12). The short term forecasts conducted by the assessment working groups in the years 2006 to 2009 were re-run using the estimates of fishing mortality determined from the most recent (2011) assessment. Comparison of the resulting estimates of removals and SSB from these forecasts with those estimates of removals and SSB from the 2011 assessment provided an indication of the ability of the short term forecasts to adequately predict the future dynamics of the stock in response to the actual level of fishing mortality that has occurred in the fishery.

Using the stock parameters from the 2010 assessment and the estimated population numbers and fishing mortalities derived from each of the annual assessments 2006 to 2010, the short term forecasts from the B-Adapt assessments were re-calculated.

*The forecast procedure*

The B-Adapt forecasts are based on 1000 bootstrap estimates of terminal values for fishing mortality and population number. Each bootstrap estimate is taken forward in time, given the forecast assumptions of 3 year means for weight at age, natural mortality, maturity, etc. The exploitation pattern was taken as the average of the last 3 years, re-scaled to the Fbar(2-4) of the final year. The forecast projected forward using total F to give total catches. These total catches were then split into landings and discard components using the landings fraction, by weight in the final year. In each forecast, recruitment values were drawn randomly from the recent time series (1998 to last data year).

The stochastic forecasts conducted by the assessment working group were run in conjunction with, and as part of, the B-Adapt stock assessment software. For this exercise the forecasts needed to be run with alternative assumptions of fishing mortality and it was therefore necessary to first recreate the original B-Adapt forecasts before re-running them with the alternative settings (see Annex 12 for further details).

### *Forecast Results*

Estimates of total removals and SSB from the short term forecasts conducted in 2006 to 2009 for those fishing mortality scenarios in accordance with the management/recovery plans are shown in Figure 6.7. This shows that for the reduced F levels, total removals from 2007 onwards would have been lower than those estimated by the 2011 assessment. Also the corresponding SSB levels from 2008 onwards were at a higher level. The level of bias in the over-estimation of future SSB is approximately equal to the under-estimation of fishing mortality, whilst total removals appear to be either relatively well predicted or else predicted to be substantially lower than the observed values. Bias in the estimates of SSB peaked with the 2007 short term forecast but have subsequently declined. This bias may be a consequence of the large 2005 year-class, which has been successively revised in recent assessments, although the full effect of this is not entirely clear.

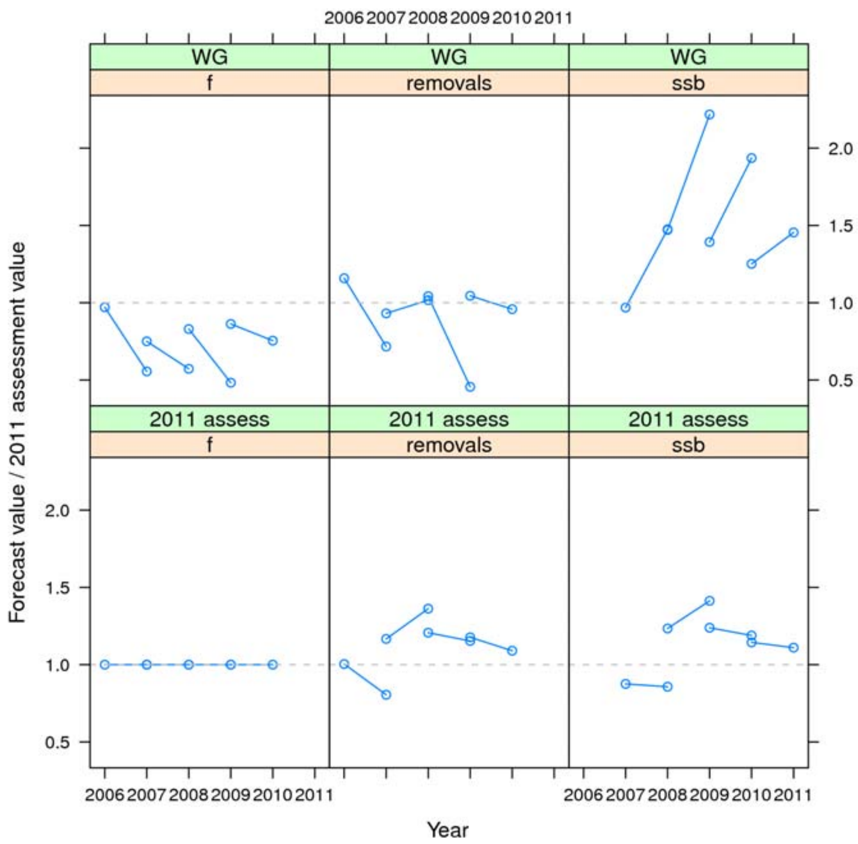



**Figure 6.7.** Estimated total removals and SSB for the years 2006 to 2011, determined from the short term forecasts for 2006 to 2009 as conducted by the WG. Values are shown relative to the 2011 assessment estimates of F, total removals and SSB. Top panel shows estimates as conducted by the WG. Lower panel shows estimates resulting from the same forecasts but using the F values determined by the 2011 assessment.

When the fishing mortality values are replaced with the estimates derived from the 2011 assessment the level of bias in removals and SSB is dramatically reduced, but is not removed completely (Figure 6.7). Predicted SSB from the forecast continues to be greater than that estimated by the 2011 assessment, but also, with the higher F values, predicted removals are estimated to be higher.

*Conclusions*

Replacing the fishing mortality levels with those estimated by the 2011 assessment yielded forecast results that were closer to the estimates of total removals and SSB derived from the 2011 assessment (Figure 6.7). This would indicate good internal consistency of the forecast procedure, but it should be noted that the forecasts appear to under-estimate the level of fishing mortality that is required to achieve the removals that have been observed in the fishery. In other words, a higher fishing mortality is required in practice to achieve the level of removals indicated in the short term forecasts conducted by the working groups.

There appears to be a bias in the short term forecast; therefore, the assumptions (such as intermediate-year F, the TAC-year F, appropriate selection patterns for discards and unallocated removals etc.) should be further evaluated to determine if there is a more appropriate method of estimating the relationship between target F, the removals, catch and TAC in the catch year.

### *6.7.3. Irish Sea Cod*

The agreed TACs have been in accordance with Article 9a of the management plan (stock considered data poor with advice for reduction of catches to the lowest possible level) since 2009. In the absence of reliable forecasts, the TAC was reduced by 25% in 2009, 2010 and 2011 (see Annex 12, Table 5). The agreed TACs, however, were above ICES advice. ICES advice was in all three years based on the precautionary approach only and aimed for zero catch. ICES states that the plan is not precautionary for this stock. STECF agreed with ICES advice for 2009, 2010 and 2011, but additionally notes that the TACs based on the management plan should be 674 tons in 2010 and 506 tons in 2011 (see Annex 12, Table 5). In the years between 2004 and the implementation of the plan, ICES and STECF advice was always zero catch. There were reductions in TAC also before the implementation of the plan. Since no short term forecasts were conducted after 2004, no implied changes in F and SSB according to short term forecasts were analysed.

Total removals (landings * scaling factor) estimated by the stock assessment decreased since 2003 but increased slightly between 2009 and 2010 (see Annex 12, Figure 14). The proportion of landings in total removals declined substantially between 2000 and 2003 (26% in 2003). After 2003 the proportion of landings increased and is now around 40%. There is no further increase in the proportion of landings since 2008. Therefore, the TAC alone cannot restrict total removals from the stock. The source of unallocated removals remains unclear, given the proportion of the fisheries (discard, high grading, and black landings) and biological (migration, natural mortality) factors cannot be specified. This makes unallocated removals to a serious problem for achieving objectives of the plan.

### *6.7.4. West of Scotland Cod*

The current cod management plan has not been accepted as precautionary for the WoS cod stock for the reason that to date it has not been possible to assess unaccounted mortality accurately. The previous cod recovery plan was also not accepted as precautionary for the same reasons. Based on the precautionary approach ICES has recommended zero catch since the advice for 2003 (Table 6.7.2). STECF either explicitly or implicitly agreed with the advice for zero catch.

The TAC was reduced by 40% in 2009 (Table 6.7.2). This was well in excess of what was estimated as necessary to achieve a 30% increase in SSB (a target of the old management plan) and also above the 25% reduction that should be applied via Article 9a of the current management plan (stock considered data poor and there is advice for reduction of catches to the lowest possible level). The TAC for 2010 did not change for area VIa and Vb (EU) compared to 2009. STECF agreed with ICES that no fishing should take place on cod in VIa and both organisations considered that if the management plan were applied article 9a should be invoked leading to a 25% cut in TAC. The final TAC was 240 t compared to 180 t if article 9a were invoked. Although unconfirmed, it is possible the 2010 TAC resulted from an administrative error. Up to and including the advice for 2009 TACs the TAC for areas VIa and Vb (EU) was declared as part of a larger TAC for areas VI, Vb EU, XII and XIV. From 2010 the TAC for VIa and Vb (EU) continued and a TAC for VIb (Rockall), VII and XIV was declared separately (Table 6.7.2). The difference between the larger area TAC for 2009 and the VIa-Vb TAC for 2010 is 21%. The 2011 TAC was set approximately in line with article 9a of the management plan; 24% reduction vs. 25% in plan (Table 6.7.2).

ICES advice for several years (e.g. 2005) has highlighted the technical interaction between cod and other stocks for vessels fishing for other gadoids (haddock and whiting) and *Nephrops*. In 2005 ICES also highlighted the high discarding rate of cod. The recorded rate of discards became considerably higher from 2006 and further increased after 2008 (see Annex 12, Figure 17). From 2006 discarding was observed at older ages (including ages 3 and 4 compared to only ages 1 and 2 previously), suggesting new legislation to eliminate under-reporting introduced in that year had been successful but also that it was still not able to reduce the mortality on the stock. The concerns, over under-reporting in earlier years, meant commercial data after 1995 has been excluded from recent stock assessments. Estimated total removals rose – by the mid 2000s - considerably above landings plus raised discards, even taking into account the significant increase in recorded discards (see Annex 12, Figure 18). The discrepancy has reduced in more recent years (i.e. between 2008 and 2009) but is still significant. In addition, estimates of cod consumed by grey seals to the west of Scotland by the Sea Mammal Research unit (SMRU, 2006, Pope and Holmes, 2008) suggest predation mortality on cod is greater than can be accommodated by the standard value of natural mortality used for WoS gadoid species. Estimates of increasing seal population also suggest there may be a trend in this predation mortality. The high discard rates and unallocated removals can be considered a serious concern preventing the plan from being successful in terms of lowering total mortality on the stock.

The effort limits and catch composition rules associated with the management plan WoS are only in effect for part of the stock area. For vessels of length 15m and over operating west of a management line (STECF 2010) effort is restricted to a lesser degree. The figure also shows locations of fishing activity using TR1 gear (from VMS data) linked to cod landings (Scottish vessels). It can be seen a large proportion of the effort falls outside of the cod management area.

Table 6.7.1: Overview of advice and agreed TACs for cod in IIIa west, IV and VIId in the years 2004 to 2011 in addition to implied changes in F and SSB according to short term forecasts used as basis for advice and TAC negotiations.

| Year | ICES Advice TAC | Rational behind ICES Advice | Agreed TAC | Change in agreed TAC | Implied F in the TAC year according to short-term forecast | F intermediate year (predicted) | Changes in F (F TAC year/ F intermediate year) | SSB after the TAC year according to short-term forecast | SSB at the beginning of TAC year (predicted) | Changes in SSB (SSB after TAC year / SSB at the beginning of TAC year) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0 | Precautionary approach | 31.2 [1] | | **No deterministic forecast presented in the Advice** | | | | | |
| 2005 | 0 | Precautionary approach | 31.2 [1] | 0 | **Only provisional forecasts, Option table not presented in the final advice** | | | | | |
| 2006 | 0 [5] | Precautionary approach | 26.5 [1] | -15% | **No Short- Term Forecast presented in the Advice** | | | | | |
| 2007 | 0 [5] | Precautionary approach | 22.9 [1] | -13.50% | 0.39 [3] | 0.85 [3] | -54% [3] | 63 [3] | 35.7 [3] | 76% [3] |
| 2008 | <22 total removals [6] | Precautionary approach | 25.4 [1] | 11% | 0.27 [4] | 0.54 [4] | -50% [4] | 127.4 [4] | 62.3 [4] | 104% [4] |
| 2009 | 0 [7] | Precautionary approach | 34.6 [2] | 36% (31% if TAC 2008 is increased by 4% to include area VIId) | 0.4 | 0.58 | -31% | 94.6 | 70.7 | 34% |
| 2010 | 40.3 [5] | Management plan (F 0.65* F2008) | 40.3 [2] | 16.50% | 0.51 | 0.59 | -13.60% | 79.6 | 66 | 21% |
| 2011 | 32.2 [5] | Management plan (F 0.55* F2008) and TAC constraint | 32.2 [2] | -20% | 0.44 | 0.74 | -40.50% | 72 | 54.3 | 32% |

[1] TAC includes areas IV, IIIa
2 TAC includes areas VIId, IV, IIIa

[3] The short term forecast only estimates total removals. Discards and unallocated removals were added to the agreed TAC to find implied Fs and SSBs in the advice table under the assumption: 50% landings, 10% discard and 40% unallocated removals (Mean 2003-2005)

[4] The short term forecast only estimates total removals. Assumed discards and unallocated removals were added to the agreed TAC to find implied Fs and SSBs in the advice table under the assumption: 56% landings, 13% discard and 31% unallocated removals (Mean 2004-2006).

[5] STECF agrees with ICES assessment and Advice

[6] According to STECF TAC in II(EU), IIIa and IV excluding 7d should be less than 26229 t

[7] ICES advice and STECF advice are outdated since the managment plan was agreed after advice was published

**Sources: ICES advice 2003-2010; STECF review of scientific advice 2005 - 2010**

Table 6.7.2: Overview of advice and agreed TACs for WoS cod in the years 2004 to 2011 in addition to implied changes in F and SSB according to short term forecasts used as basis for advice and TAC negotiations.

| Year | ICES Advice | Rational behind ICES Advice | Agreed TAC (t) | Change in agreed TAC | Implied F in the TAC year according to short-term forecast | F intermediate year (predicted) | Changes in F (F TAC year/ F intermediate year) | SSB after the TAC year according to short-term forecast | SSB at the beginning of TAC year (predicted) | Changes in SSB (SSB after TAC year / SSB at the beginning of TAC year) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0#1 | Precautionary approach | 814 (848)#4 | | 0.37 | 1.01 | -63% | 3213 | 2170 | 48% |
| 2005 | 0#2 | Precautionary approach | 692 (721)#4 | -15% | **Short-Term Forecasts (landings and discards) - three alternative final assessments - conducted but not presented in the Advice** | | | | | |
| 2006 | 0#2 | Precautionary approach | 588 (613)#4 | -15% | **Short-Term Forecast (total removals) - using SURBA - conducted but not presented in the Advice** | | | | | |
| 2007 | 0#1 | Precautionary approach | 490 (556)#4 | -17% | **Short-Term Forecast (total removals) - using SURBA - conducted but not presented in the Advice** | | | | | |
| 2008 | 0#1 | Precautionary approach | 402 (447)#4 | -18% | **Short-Term Forecast (total removals) conducted but not presented in the Advice** | | | | | |
| 2009 | 0#1 | Precautionary approach | 240 (302)#4 | -40% | **Short-Term Forecast (total removals) conducted but not presented in the Advice** | | | | | |
| 2010 | 0#3 | Precautionary approach | 240 (80)#5 | 0% | **Short-Term Forecast (total removals) conducted but not presented in the Advice** | | | | | |
| 2011 | 0#3 | Precautionary approach | 182 (78)#5 | -24% | **Short-Term Forecast (total removals) conducted but not presented in the Advice** | | | | | |

#1 STECF agreed with ICES advice
#2 STECF only noted 'critically low level' of VIa cod
#3 STECF agrred with ICES advice (both organisations also agreed article 9a should be used if the management plan is applied)
#4 TAC for VIa and EU waters of Vb declared as part of TAC for VI, EU waters of Vb and XII and XIV (larger TAC given in brackets)
#5 TAC for VIa and international waters of Vb east of 12 degrees W (TAC for VIb and Vb west of 12 degrees west and XII and XIV given in brackets)
**Sources: ICES advice 2004-2010; STECF review of scientific advice 2003 - 2010**

## 6.8. Reference points and MSY by 2015

### *6.8.1. Reference points*

Regarding precautionary and MSY reference points, ICES WKCOD provide the following view for North Sea cod (redrafted here without changing the meaning).

Although the SAM model structure agreed at WKCOD is considered the most appropriate that could be fitted in the time available, a refined model structure will only be completed with further work. Consequently, WKCOD considered that if further refinements are found to be required before the WGNSSK 2011 meeting, these be presented to that meeting for adoption (WGNSSK comprises a large part of WKCOD participants). In the medium term WKCOD considered that the development of a model structure that models discard and landings separately is required due to the differing levels of noise associated with each data set. WKCOD recommended that the reference points are not revised in the short term until the assessment model has been finalised as revision may not be sufficiently stable if further amendments to the model are included.

This Workshop concluded that it is appropriate to wait for these results and continue to accept the current values of precautionary and MSY reference points as they are currently not impacting on exploitation.

### *6.8.2. Achievement of MSY by 2015*

For cod in the Kattegat, no medium term simulations were performed. In a present situation where the fishing mortality is unknown, and landings and assumed natural mortality are not representing the removals from the stock, simulations of future developments are not considered informative.

For cod in North Sea, West of Scotland and Irish Sea the assessment provides some indication of state of the stock and possible changes in mortality during the plan. In order to answer the question “Is the plan likely to achieve MSY by 2015?”, simulations were carried using the MSE simulation framework previously used for an Impact Assessment of the HCR components (Articles 7 and 8) of Council Regulation (EC) 1342/2008 for West of Scotland and Irish Sea cod, and using a similar framework for North Sea cod (Annex 13). The probabilities of achieving reference levels for each stock and scenario are presented in Tables 6.8.2-6.

If the catches under the plan were to be implemented in terms of F, North Sea and West of Scotland cod have a high probability (>95%) of recovery above Blim by 2015 for both recruitment models (“standard” and “low”) for the scenarios that correspond to the way in which these stocks are currently assessed (bias in catch). This drops to 80% for “standard” recruitment and <60% for “low” recruitment for Irish Sea cod, because of the poor state of this stock.

A common feature across all stocks is if the catches under the plan were to be implemented in terms of F and TAC constraint, fishing mortality would be driven to levels much lower than previously seen, because the imposition of TAC constraints (± 20%) prevents TAC increases from keeping pace with the potentially rapid recovery that occurs as a result of the target F (0.4) of the management plans. A consequence is that in all cases for “standard” recruitment and for the way in which the stocks are currently assessed, following the fishing mortality objectives for the plan has a high probability of reducing to Fmsy or below by 2015: 100%, 100% and 90% for

North Sea, West of Scotland and Irish Sea cod, respectively. This very high probability reduces somewhat for “low” recruitment, but nevertheless remains relatively high: 84%, 99% and 76% for North Sea, West of Scotland and Irish Sea cod, respectively.

When TAC constraints are removed, and the F targets under the plan implemented all stocks have a fishing mortality in 2015 that is closer to the target of 0.4, and higher yields in the case of “standard” recruitment, than when TAC constraints are imposed. This is also the case for “low” recruitment for North Sea and West of Scotland cod, but not for Irish Sea cod, where performance of the management plan in terms of both recovery and yield is poorer when TAC constraints are removed compared to when they are imposed. This implies that for a stock in particularly poor condition, it may be beneficial to impose TAC constraints to prevent a harvest control rule from setting TACs too high based on inaccurate information, thus damaging the resource further.

In order to reflect the current rates of change in exploitation simulations were also carried projecting future fishing mortality rates at the recently observed trends for each stock; no reductions in F for the Irish Sea and West of Scotland stocks and a 1.5% annual reduction in the F in the North Sea, without any specific feedback from the management plan, which is treated as if its recent performance will continue. This means that only the OM=cat/M and SR=1/0.5 options in Table ii are needed. Tables 8.2.4, 5 and 6 for North Sea West of Scotland and Irish Sea respectively. For North Sea the predictions show relatively high probability of SSB>Blim by 2015, but low probabilities of being above Bpa, though the actual percentages depend on the recruitment assumptions. For West of Scotland the probability of SSB>Blim depends mostly on recruitment assumptions, if recruitment follows the low recruitment assumption these simulations suggest that SSB with remain below Blim, however, if the higher recruitment assumption is correct, SSB is expected to rise close to Blim. There is a low probability of reaching Bpa under all the assumptions if F remains the same. For the Irish Sea there is a low probability of SSB>Blim (or Bpa) if F remains at current levels.

In conclusion the medium term simulations indicate that the primary factor in recovery is the assumption or not of success in reducing F. A secondary but important effect is the underlying assumption of S-R relationship. For the North Sea cod the source of unaccounted mortality (catch or M) changes predicted responses, but mostly in the longer term or at larger stock size. For the West of Scotland the uncertainty about the unaccounted mortality has an important contribution, and does influence the expected response in the short term. For the Irish Sea current estimates of unaccounted mortality indicate this does not greatly influence the expected stock response.

**Table 6.8.1.** North Sea cod. Summary results for 14 scenarios for the year 2015. The columns labelled "OM", "SR", "OEM", and "TAC con" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii, Annex 13. Values for the reference points used are given in Table I, Annex 13 , and the summary statistics are described in Table iii Annex 13. Values for SSB, L, D and C are in thousand tons.

| | OM | SR | OEM | TAC con | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **cat** | **20%** | **1.00** | **1.00** | **0.99** | **1.00** | **1.00** | **370** | **53.3** | **14.8** | **68.2** | **0.06** | **0.02** | **0.08** |
| 2 | cat | 1 | m | 20% | 1.00 | 1.00 | 0.98 | 1.00 | 1.00 | 357 | 56.8 | 15.7 | 72.9 | 0.06 | 0.02 | 0.09 |
| 3 | cat | 1 | wg | 20% | 1.00 | 1.00 | 0.82 | 0.94 | 1.00 | 330 | 70.9 | 20.6 | 92.0 | 0.09 | 0.03 | 0.12 |
| 4 | m | 1 | cat | 20% | 1.00 | 1.00 | 0.99 | 1.00 | 1.00 | 274 | 40.4 | 12.1 | 52.8 | 0.06 | 0.02 | 0.08 |
| 5 | m | 1 | m | 20% | 1.00 | 0.99 | 0.98 | 1.00 | 1.00 | 266 | 43.0 | 12.9 | 56.1 | 0.07 | 0.02 | 0.09 |
| 6 | m | 1 | wg | 20% | 1.00 | 0.97 | 0.82 | 0.94 | 1.00 | 248 | 53.6 | 16.7 | 70.8 | 0.09 | 0.03 | 0.12 |
| **7** | **cat** | **0.5** | **cat** | **20%** | **1.00** | **0.98** | **0.65** | **0.84** | **1.00** | **241** | **52.2** | **11.6** | **64.1** | **0.11** | **0.04** | **0.14** |
| 8 | cat | 0.5 | m | 20% | 1.00 | 0.96 | 0.53 | 0.75 | 1.00 | 227 | 54.1 | 12.1 | 66.4 | 0.12 | 0.04 | 0.16 |
| 9 | cat | 0.5 | wg | 20% | 1.00 | 0.83 | 0.10 | 0.25 | 0.98 | 197 | 67.7 | 16.4 | 84.7 | 0.17 | 0.06 | 0.23 |
| 10 | m | 0.5 | cat | 20% | 1.00 | 0.75 | 0.59 | 0.80 | 1.00 | 177 | 39.2 | 9.6 | 49.2 | 0.11 | 0.04 | 0.15 |
| 11 | m | 0.5 | m | 20% | 1.00 | 0.70 | 0.50 | 0.74 | 1.00 | 169 | 39.9 | 9.9 | 50.3 | 0.12 | 0.04 | 0.16 |
| 12 | m | 0.5 | wg | 20% | 1.00 | 0.49 | 0.09 | 0.23 | 0.99 | 149 | 50.5 | 13.3 | 64.6 | 0.17 | 0.06 | 0.23 |
| 13 | cat | 1 | cat | - | 1.00 | 1.00 | 0.08 | 0.17 | 1.00 | 324 | 131.5 | 40.1 | 173.8 | 0.18 | 0.06 | 0.24 |
| 14 | cat | 0.5 | cat | - | 1.00 | 0.97 | 0.02 | 0.05 | 0.98 | 219 | 86.1 | 20.4 | 107.8 | 0.21 | 0.07 | 0.28 |

**Table 6.8.2.** West of Scotland cod. Summary results for 14 scenarios for the year 2015. The columns labelled “OM”, “SR”, “OEM”, and “TAC con” refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii, Annex 13. Values for the reference points used are given in Table I, Annex 13 , and the summary statistics are described in Table iii Annex 13. Values for SSB, L, D and C are in thousand tons.

| | OM | SR | OEM | TAC con | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **cat** | **20%** | **1.00** | **0.99** | **1.00** | **1.00** | **1.00** | **54.4** | **0.844** | **0.777** | **1.581** | **0.01** | **0.02** | **0.03** |
| 2 | cat | 1 | m | 20% | 1.00 | 0.99 | 1.00 | 1.00 | 1.00 | 54.5 | 0.618 | 0.627 | 1.263 | 0.01 | 0.02 | 0.02 |
| 3 | cat | 1 | wg | 20% | 1.00 | 0.99 | 1.00 | 1.00 | 1.00 | 54.5 | 0.774 | 0.714 | 1.486 | 0.01 | 0.02 | 0.03 |
| 4 | m | 1 | cat | 20% | 0.72 | 0.39 | 0.95 | 0.97 | 1.00 | 19.9 | 0.377 | 0.545 | 0.902 | 0.02 | 0.04 | 0.06 |
| 5 | m | 1 | m | 20% | 0.72 | 0.40 | 1.00 | 1.00 | 1.00 | 20.0 | 0.252 | 0.360 | 0.610 | 0.01 | 0.03 | 0.04 |
| 6 | m | 1 | wg | 20% | 0.72 | 0.40 | 0.98 | 0.99 | 1.00 | 19.9 | 0.330 | 0.481 | 0.796 | 0.02 | 0.03 | 0.05 |
| **7** | **cat** | **0.5** | **cat** | **20%** | **0.99** | **0.89** | **0.98** | **0.99** | **1.00** | **32.6** | **0.788** | **0.533** | **1.307** | **0.01** | **0.03** | **0.04** |
| 8 | cat | 0.5 | m | 20% | 0.99 | 0.92 | 1.00 | 1.00 | 1.00 | 33.0 | 0.442 | 0.313 | 0.742 | 0.01 | 0.02 | 0.03 |
| 9 | cat | 0.5 | wg | 20% | 0.99 | 0.90 | 0.99 | 0.99 | 1.00 | 32.9 | 0.655 | 0.460 | 1.105 | 0.01 | 0.03 | 0.04 |
| 10 | m | 0.5 | cat | 20% | 0.32 | 0.10 | 0.86 | 0.90 | 0.98 | 10.5 | 0.377 | 0.364 | 0.712 | 0.03 | 0.06 | 0.09 |
| 11 | m | 0.5 | m | 20% | 0.33 | 0.10 | 1.00 | 1.00 | 1.00 | 10.8 | 0.143 | 0.181 | 0.329 | 0.01 | 0.03 | 0.04 |
| 12 | m | 0.5 | wg | 20% | 0.33 | 0.10 | 0.94 | 0.97 | 1.00 | 10.5 | 0.252 | 0.287 | 0.555 | 0.02 | 0.05 | 0.07 |
| 13 | cat | 1 | cat | - | 0.84 | 0.59 | 0.13 | 0.16 | 0.32 | 25.8 | 3.765 | 5.961 | 10.173 | 0.15 | 0.35 | 0.50 |
| 14 | cat | 0.5 | cat | - | 0.52 | 0.28 | 0.22 | 0.25 | 0.39 | 14.9 | 1.913 | 2.493 | 4.466 | 0.13 | 0.30 | 0.43 |

**Table 6.8.3.** Irish Sea cod. Summary results for 14 scenarios for the year 2015. The columns labelled "OM", "SR", "OEM", and "TAC con" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii, Annex 13. Values for the reference points used are given in Table I, Annex 13 , and the summary statistics are described in Table iii Annex 13. Values for SSB, L, D and C are in thousand tons.

| | OM | SR | OEM | TAC con | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **cat** | **20%** | **0.80** | **0.54** | **0.68** | **0.90** | **0.94** | **10.7** | **2.188** | **0.000** | **2.188** | **0.18** | **0.00** | **0.18** |
| 2 | cat | 1 | m | 20% | 0.90 | 0.62 | 0.95 | 0.98 | 0.99 | 11.9 | 1.300 | 0.000 | 1.300 | 0.10 | 0.00 | 0.10 |
| 3 | cat | 1 | wg | 20% | 0.80 | 0.56 | 0.71 | 0.90 | 0.94 | 11.0 | 2.097 | 0.000 | 2.097 | 0.17 | 0.00 | 0.17 |
| 4 | m | 1 | cat | 20% | 0.26 | 0.08 | 0.48 | 0.80 | 0.90 | 3.4 | 0.758 | 0.000 | 0.758 | 0.25 | 0.00 | 0.25 |
| 5 | m | 1 | m | 20% | 0.28 | 0.08 | 0.86 | 0.98 | 0.99 | 3.6 | 0.457 | 0.000 | 0.457 | 0.14 | 0.00 | 0.14 |
| 6 | m | 1 | wg | 20% | 0.26 | 0.08 | 0.54 | 0.81 | 0.90 | 3.4 | 0.699 | 0.000 | 0.699 | 0.23 | 0.00 | 0.23 |
| **7** | **cat** | **0.5** | **cat** | **20%** | **0.57** | **0.24** | **0.52** | **0.76** | **0.84** | **6.6** | **1.685** | **0.000** | **1.685** | **0.25** | **0.00** | **0.25** |
| 8 | cat | 0.5 | m | 20% | 0.65 | 0.31 | 0.87 | 0.94 | 0.97 | 7.5 | 0.992 | 0.000 | 0.992 | 0.12 | 0.00 | 0.12 |
| 9 | cat | 0.5 | wg | 20% | 0.58 | 0.24 | 0.49 | 0.71 | 0.80 | 6.6 | 1.652 | 0.000 | 1.652 | 0.25 | 0.00 | 0.25 |
| 10 | m | 0.5 | cat | 20% | 0.04 | 0.00 | 0.18 | 0.47 | 0.66 | 1.6 | 0.519 | 0.000 | 0.519 | 0.41 | 0.00 | 0.41 |
| 11 | m | 0.5 | m | 20% | 0.04 | 0.00 | 0.53 | 0.76 | 0.89 | 1.8 | 0.330 | 0.000 | 0.330 | 0.24 | 0.00 | 0.24 |
| 12 | m | 0.5 | wg | 20% | 0.04 | 0.00 | 0.23 | 0.48 | 0.63 | 1.6 | 0.480 | 0.000 | 0.480 | 0.41 | 0.00 | 0.41 |
| 13 | cat | 1 | cat | - | 0.54 | 0.25 | 0.20 | 0.42 | 0.60 | 6.2 | 2.607 | 0.000 | 2.607 | 0.45 | 0.00 | 0.45 |
| 14 | cat | 0.5 | cat | - | 0.25 | 0.07 | 0.25 | 0.49 | 0.64 | 3.8 | 1.238 | 0.000 | 1.238 | 0.40 | 0.00 | 0.40 |

Table 6.8.4. North Sea cod. Summary results for 4 scenarios for the year 2015. The columns labelled "OM", "SR", "OEM", and "TAC con" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii, Annex 13. Values for the reference points used are given in Table I, Annex 13 , and the summary statistics are described in Table iii Annex 13. Values for SSB, L, D and C are in thousand tons.

| | OM | SR | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **0.99** | **0.36** | **0.00** | **0.00** | **0.00** | **134** | **128.4** | **46.4** | **176.6** | **0.40** | **0.14** | **0.54** |
| 4 | m | 1 | 0.98 | 0.26 | 0.00 | 0.00 | 0.50 | 126 | 93.0 | 34.1 | 128.4 | 0.31 | 0.11 | 0.42 |
| **7** | **cat** | **0.5** | **0.85** | **0.04** | **0.00** | **0.00** | **0.00** | **94** | **74.6** | **21.9** | **96.7** | **0.40** | **0.14** | **0.54** |
| 10 | m | 0.5 | 0.78 | 0.02 | 0.00 | 0.00 | 0.50 | 87 | 53.5 | 16.1 | 69.9 | 0.31 | 0.11 | 0.42 |

Table 6.8.5. West of Scotland cod. Summary results for 4 scenarios <u>for the year 2015</u>. The columns labelled “OM”, “SR”, “OEM”, and “TAC con” refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii, Annex 13. Values for the reference points used are given in Table 1, Annex 13 , and the summary statistics are described in Table iii Annex 13. Values for SSB, L, D and C are in thousand tons.

| | OM | SR | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **0.38** | **0.08** | **0.00** | **0.00** | **0.00** | **11.9** | **2.509** | **5.906** | **8.299** | **0.28** | **0.65** | **0.93** |
| 4 | m | 1 | 0.43 | 0.15 | 0.00 | 0.01 | 0.61 | 12.6 | 1.027 | 1.925 | 2.970 | 0.09 | 0.22 | 0.31 |
| **7** | **cat** | **0.5** | **0.02** | **0.00** | **0.00** | **0.00** | **0.00** | **6.0** | **1.398** | **2.479** | **3.957** | **0.28** | **0.65** | **0.93** |
| 10 | m | 0.5 | 0.08 | 0.00 | 0.00 | 0.01 | 0.61 | 6.6 | 0.597 | 0.843 | 1.457 | 0.09 | 0.22 | 0.31 |

Table 6.8.6. Irish Sea cod. Summary results for 4 scenarios <u>for the year 2015</u>. The columns labelled “OM”, “SR”, “OEM”, and “TAC con” refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii, Annex 13. Values for the reference points used are given in Table 1, Annex 13 , and the summary statistics are described in Table iii Annex 13. Values for SSB, L, D and C are in thousand tons.

| | OM | SR | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **2.4** | **2.544** | **0.000** | **2.544** | **1.39** | **0.00** | **1.39** |
| 4 | m | 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 2.6 | 0.908 | 0.000 | 0.908 | 0.46 | 0.00 | 0.46 |
| **7** | **cat** | **0.5** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **1.2** | **1.211** | **0.000** | **1.211** | **1.39** | **0.00** | **1.39** |
| 10 | m | 0.5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 1.3 | 0.447 | 0.000 | 0.447 | 0.46 | 0.00 | 0.46 |

# 7. EVALUATION OF THE EFFECTS OF THE MULTI-ANNUAL PLAN ON THE ECOSYSTEM (ADDITIONALLY TO STOCK AND FISHERY).

## 7.1. Mixed fishery and discarding

Implicitly, a TAC assumes that the level of fishing activity will adapt to the quota available for a particular stock, and will lead to the targeted level of fishing mortality. The simplest link is to assume that vessels will stop catching a given species once their quota for that species is exhausted. The likelihood this assumption holds true lessens for complex, multispecies, multigear fisheries, where fleets are given a set of different fishing opportunities for the various stocks. The recent history of the North Sea cod is a good example of the problems of using TACs to manage mixed fisheries. In 2005-06, the North Sea cod stock was at a historic low biomass whereas the stock of haddock, which is to a large extent caught together with cod, was at its highest biomass in 30 years (ICES, 2009b). Single-species TACs were set with no consideration of the status of the other stocks caught in the same fishery. Fishermen were faced with a dilemma when the quota for cod was exhausted: stop fishing and underutilize the quota for haddock, or continue fishing and discard or illegally land overquota cod. If they choose either of the latter options, the cod TAC does not achieve its intended conservation objective. Moreover, the reliability of the assessment of the cod stock is jeopardized because the catch data on which it is based tends to become more uncertain as a result of discarding or non-reporting of landings (Reeves and Pastoors, 2007; Hamon et al., 2007).

In the early 2000s a fleet based allocation key (MTAC) was developed with the aim of maximising catch allocations across fleets involved in mixed fisheries including cod, by selecting an optimal allocation by fleet to maximise total yield from the available set of single species TACs, while conforming to limits on cod. Advice based on this method was produced annually by STECF. However, once this allocation key was derived, giving advice on the highest catch overall possible, conditional on the allocation, no action was taken to enforce the management implied by the process. In consequence the optimal choice could not be achieved, and catch exceed TACs for cod as a result.

Following this, and to shed light on the consistency of single species TACs within a management area, a simple approach, using existing catch and effort information was developed, estimating catch potentials for distinct fleets (groups of vessels) and métiers (type of activity), and hence quantifying the risks of over- and underquota utilization for the various stocks. This method, named Fcube (Fleet and Fisheries Forecast, Ulrich et al., 2011), has been applied to North Sea stocks to date (ICES WKMIXFISH and ADGNS, 2009; ICES WGMIXFISH 2010).

The method as currently used assumes constant fleet specific catchabilities on the different stocks and constant relative effort between métiers within each fleet going forwards in time and each year, (though other options are available)_a number of scenarios are run, of which 3 are of interest for the current evaluation:

- cod: The underlying assumption is that all fleets set their effort at the level corresponding to their cod quota share, regardless of other stocks.

- sq_E: The effort is simply set as equal to the effort in the most recently recorded year for which there are landings and discard data.

- Ef_Mgt: The effort in métiers using gears controlled by the EU effort management regime have their effort adjusted according to the regulation (Council Regulation (EC) No 1342/2008), i.e. -25% in TR1 and TR2 effort in 2009, and additionally -10% for each successive years.

### *Comparison to single species advice for 2010*

In 2009 (TAC advice for 2010), the target F for the intermediate year 2009 in the individual single-stock forecasts implied a F reduction of 25%, 11% and 5% for cod, haddock and saithe respectively. Considering the cod scenario, the mixed fisheries analyses indicate that the 25% reduction in F required for cod also implies that the catch potential for other species, notably plaice and sole, would be undershot by 15 to 25%. Assuming the 25% reduction of effort in the gears TR1 (bottom trawls and seines > 100mm) and TR2 (bottom trawls and seines 70-100mm) was applied in 2009 (Ef_Mgt scenario), lead to lesser reductions of potential catch for some species (especially sole), but comparatively stronger impact on catch potentials for haddock, whiting and *Nephrops*. Assuming again that there should be no overshoot of the cod TAC in 2010 (cod scenario) or that the effort reductions would be adhered to (Ef_Mgt) implied strong reductions in effort, leading to potential TAC undershoots of between 15 and 40% for the other stocks compared to the single-stock forecast.

STECF estimates that between 2008 and 2009, the effort decreased by only 1% in TR1 and 6% in TR2, implying a scenario closer to the sq_E scenario and according to the latest ICES cod assessment, F(2009) hardly decreased compared to F(2008). In the MIXFISH projection, this sq_E scenario estimated the potential cod "landings" (i.e. the non-discarded part of the catches) to be 29% above the single-stock cod forecast, implying a SSB at the start of 2010 22% lower than suggested. With TAC enforcement controlling landings, these additional 'landings' might be expected to be discarded. Accounting for the additional catches in the sq_E scenario outcomes in the single-stock cod forecast for 2010 would have resulted in lower recommended catch and reducing the 2010 TAC down by a further 20% to 31 kt instead of 38 kt.

*Comparison to single species advice for 2011*

In 2010 ICES provided advice according to both the long term management plan and the FMSY framework, and both lines of advice were tested in the mixed fisheries framework. Status quo F was assumed for all stocks for the intermediate year (2010) in the single-stock forecasts under the MSY Advice Approach. In the MP Advice Approach, a 13% F reduction was applied to cod.

Differences in outcomes from the scenarios considered were noticeably smaller than found the previous year indicating greater consistency both across the individual single-stock forecasts and advice and between the single stock TACs and the sq_E scenario. However, the cod scenario always gave the lowest catch potentials for all stocks, indicating again that the cod stock is the most limiting stock for 2011, and that those reductions/redirections in effort are needed if the cod advice is to be followed. The Ef_Mgt scenario implied large effort reductions in 2010 in the main cod métiers (TR1, TR2 and BT2; beam trawls 80-120 mm), and this was expected to have a considerable impact on the catch potential of all other stocks considered (15 to 30% reductions). Overall, this scenario indicated a larger reduction in F in 2010 compared to the single-stock cod forecast. For the TAC advice in 2011, strict implementation of the simulated effort reductions would bring the fisheries to a level (estimated Fbar=0.45) almost equivalent to the expectation of the cod management plan (target F=0.44), but with potentially large catch undershooting for all other stocks compared to the single-stock advice (around 40% undershoot for haddock and plaice, 60% for all *Nephrops* and 20-30% for sole and saithe).

In conclusion, it was earlier shown that a one issue in the implementation of the North Sea cod LTMP was the overoptimistic short-term forecast that assumed perfect achievement of the LTMP objectives in terms of F reduction. The mixed-fisheries analyses conducted by ICES WGMIXFISH shed some light on a potentially important source of implementation error, with a real F being potentially higher than expected due to technical interactions. This allows also estimating its potential consequences in terms of scientific advice.

## 7.2. Approaches for reduction of impact

Adaptations by member states to reduce cod catches have focussed on two primary tools (i) modifications to fishing gear design aimed at reducing cod catchability or (ii) tactical avoidance of areas with higher cod abundance through spatially and temporally closures e.g. Real Time Closures under UK conservation credits scheme, or through spatially fixed closures e.g. Irish VIa Cape Closure, Swedish and Danish closures in the Kattegat.

### *7.2.1. Gear modifications used under Article 13(c).*

Here we review the fishing gear modifications applied to date, the level of uptake by individual member states and what their potential impact may be on catches of cod and other species.

Thus far, most of these gear modifications have been used to increase effort allocations under the provisos of Article 13(c). One gear modification, commonly referred to as the 'Swedish grid' has enabled two member states (Sweden and Ireland) to obtain exemptions under the provisions of Article 11(2).

Without exception, all modifications are associated with towed gears belonging to the TR2 and TR1 categories. While there are technical modifications applicable to beam trawls (BT1 and BT2), there has been no application of these under the provisions of Article 13(c).

Most of the modifications rely on exploiting differences in behavioural reactions between cod and the target species. So far, two gear designs have been formally used. The 'eliminator' or Orkney' trawl is used to a limited degree by the Scottish TR1 fleet under the Scottish Conservation Credits Scheme and the SELTRA 180 has recently been introduced into the Danish TR2 fleet operating in the Kattegat. The uptake of the SELTRA 180 trawl has been incentivised by permitting fishing inside an otherwise closed area.

**The Eliminator or Orkney trawl**

The eliminator trawl (Fig. 7.2.1) was first developed and used in the mixed demersal fisheries in the North Eastern US to maintain access to the haddock fishery that would otherwise be closed due to restrictive fishing opportunities for cod (Beutel, 2008). The design achieved cod reductions by 80% while still maintaining haddock.

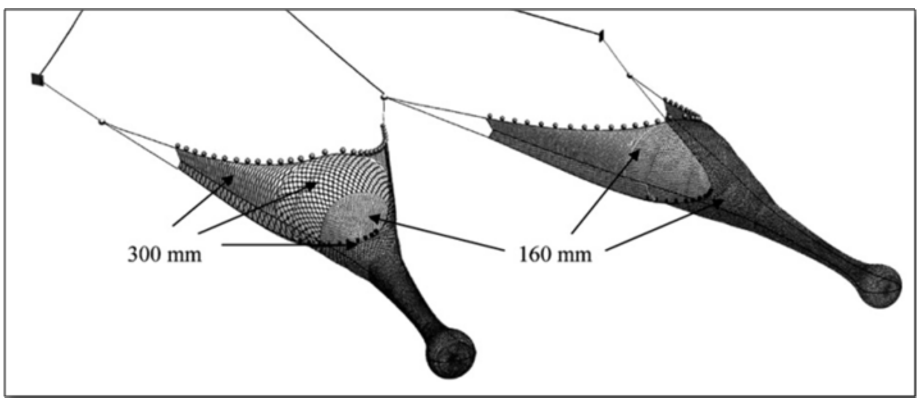



**Figure 7.2.1.** The forward sections of the Orkney gear has 300 mm diamond mesh netting in place of the 160 mm forward sections usually towed by the commercial vessel used for the experimental evaluation.

Collaborative experiments conducted between Marine Science Scotland and the Scottish Fishermen's Federation (Campbell, et al, 2010) tested the effectiveness of a trawl where the normal 160 mm mesh size netting in the forward sections of the gear was replaced with 300 mm mesh size netting in the North Sea mixed whitefish fishery. This mesh size is considerably smaller than the 2400mm mesh size used by Beutel (2008). Despite the reduced mesh size, the results show that the modified gear retains significantly fewer cod (27%), the reduction was length dependent, with no significant difference in cod catches >78cm. While there was no significant difference in whiting catches, the haddock catches were significantly higher. This is attributed to an increase in the vertical opening of the trawl. However, catches of both megrim and monkfish were significantly reduced, although there was no significant difference in catches on monkfish >55cm. Figure 7.2.2 show the relative catch rates of cod, monkfish and megrim compared to the standard gear.

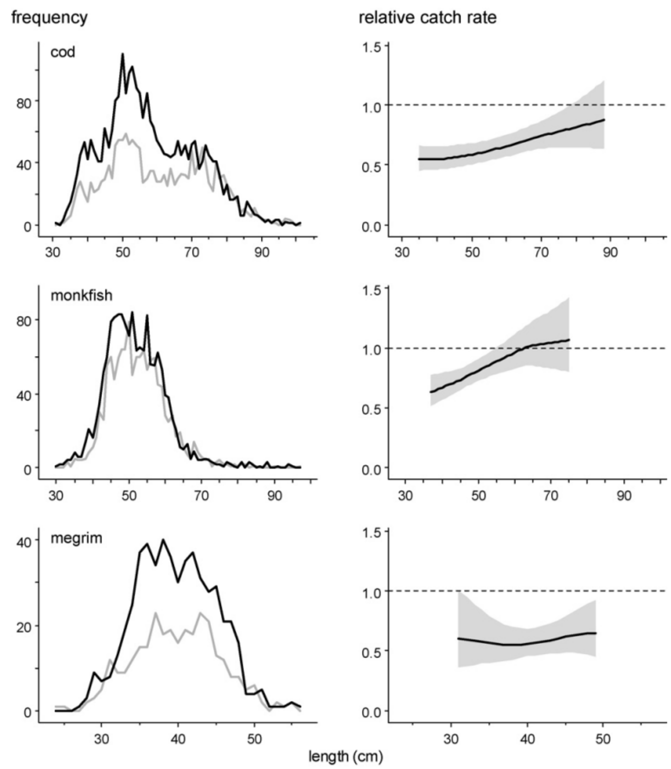



**Figure 7.2.2** The left panels show the length frequencies of cod, monkfish and megrim catches in the control (black line) and Orkney (grey line) gears. The right panels show the mean catch rate of the Orkney gear relative to the control gear (solid line) with pointwise 95% confidence intervals (grey shaded area). The horizontal dashed line indicates a constant relative catch rate of unity. The mean catch rate curves are restricted to lengths found in at least half the hauls and hence there may be some interpolation at some length classes.

The impact on catch rates of a wider range of species are reported by Kynoch et al (2011). Comparative fishing trials investigated the effect of increasing the mesh size in the forward sections of a trawl from 120 and 160 mm to (i) 300 mm and (ii) 600 mm on the catches in the Shetland mixed whitefish fishery. The 300 and 600 mm trawls respectively caught an estimated 49 and 75% fewer Atlantic cod (*Gadus morhua*), 79 and 93% fewer megrim (*Lepidorhombus whiffiagonis*), 36 and 68% fewer ling (*Molva molva*), and 28 and 53% fewer hake (*Merluccius merluccius*) than the control trawl at all lengths. The 300 mm trawl caught ~40% more haddock (*Melanogrammus aeglefinus*) than the 600 mm and control trawls which had similar catch rates. The catch rates for monkfish (*Lophius piscatorius*) were length dependent and the 300 mm trawl caught ~50% fewer monkfish at 30 cm with no significant difference > 76 cm. The 600 mm trawl caught ~90% fewer monkfish at 30 cm with no significant difference > 83 cm. Both the 300 mm and 600 mm trawls caught significantly fewer saithe (*Pollachius virens*) above 53 cm. Figure 7.2.3 shows the catch rates for seven species relative to the standard gear, the horizontal dashed line indicates no difference between the standard and test gears.

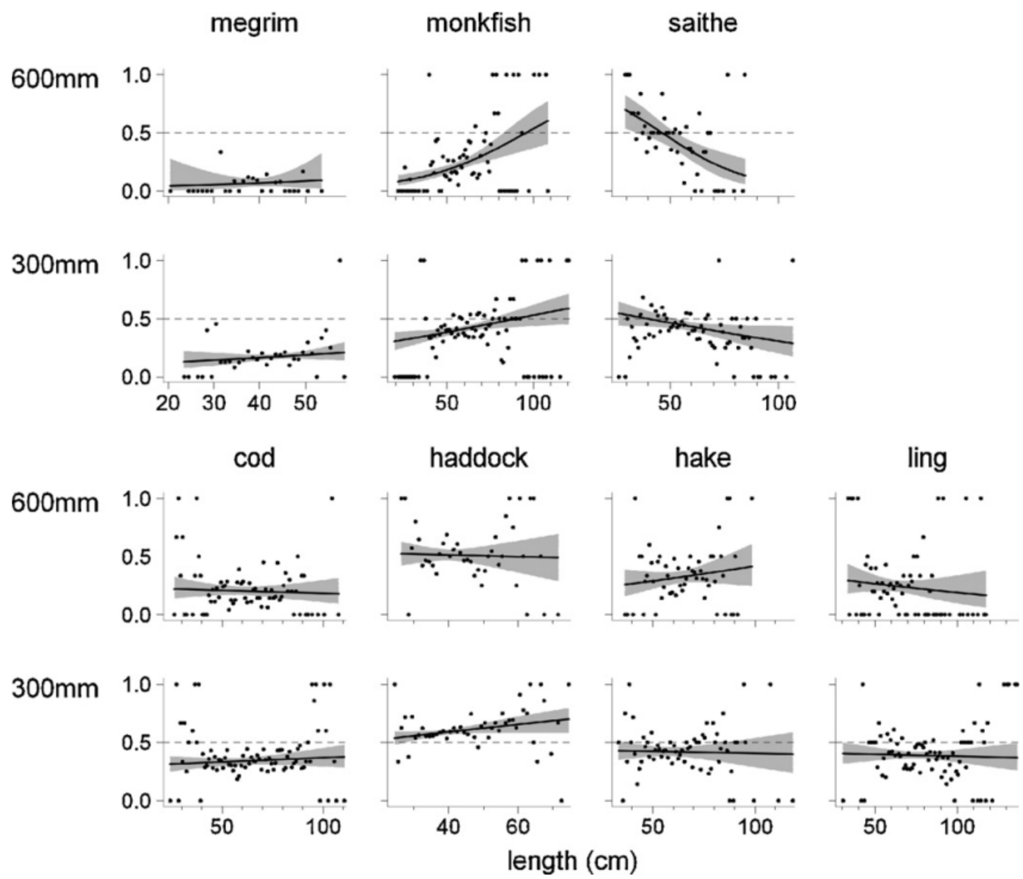



**Figure 7.2.3.** The data are summarised by the proportions of fish retained in the test codend (of those retained in both codends) pooled over hauls for each test trawl and species (points). The effect of length on relative catch rates is captured by the fitted linear logistic functions of length (solid lines), with their pointwise 95% confidence bands (shaded areas). The horizontal dashed reference line indicates no difference in catch between the test and control trawls (from Kynoch *et al*, 2011).

The results from both experiments show that the use of the Orkney trawl significantly impacts on catches of other species. Figure 7.2.4 shows the difference in mean catch weights per haul (kg) by species between the standard trawl and the Orkney trawl with 300mm mesh. Figure 7.2.5 shows the comparison between the standard trawl and the Orkney trawl with 600mm mesh. Contrasting the two figures, it is clear to see the impact on cod catches is greater with the 600mm net but losses of other commercial species are also greater.

To incentive the use of the Orkney trawl the UK (Scottish) authorities 2009 SCCS there was an incentive of either an additional 20 days or 12% of track record allocation for using gears with 300 mm diamond mesh netting in their forward section. In recognition of the greater impact on cod catches, the incentive offered by the SCCS for using the Orkney Gear with 600mm mesh was either an additional 24 days or 15% of track record allocation.

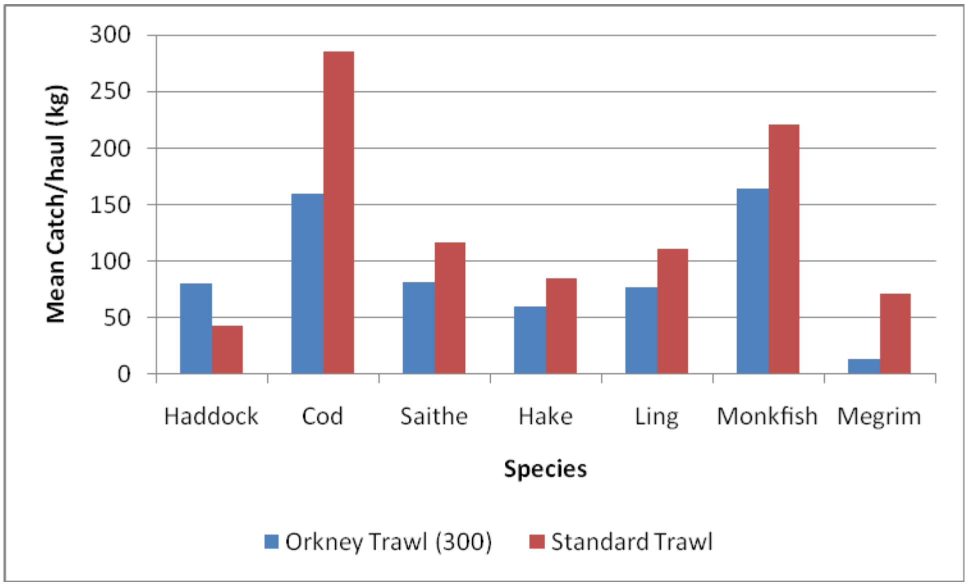



**Figure 7.2.4.** Impact on mean catch weights (kg) per haul between a standard trawl and an Orkney trawl constructed with 600mm mesh in the forward section of the trawl.

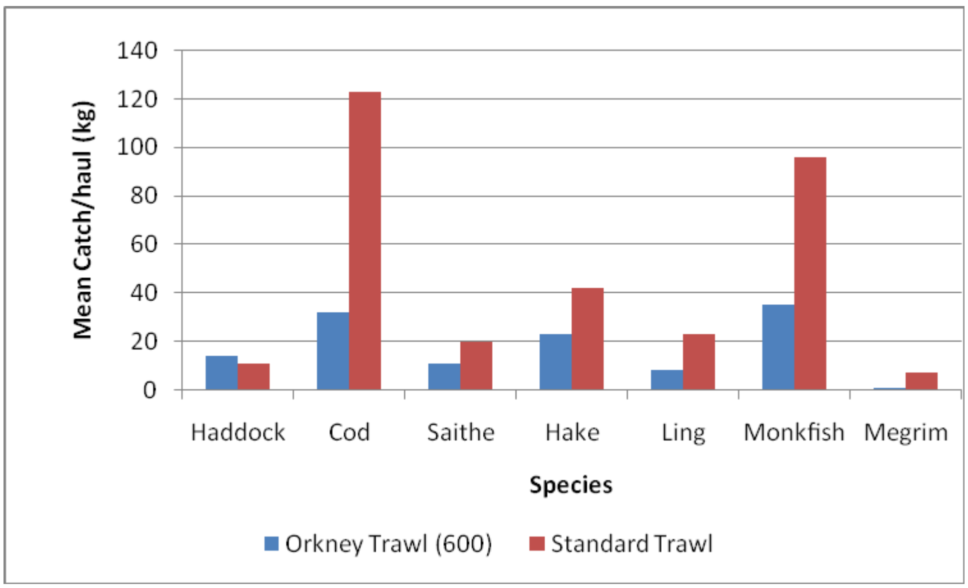



**Figure 7.2.5.** Impact on mean catch weights (kg) per haul between a standard trawl and an Orkney trawl constructed with 600mm mesh in the forward section of the trawl.

Since 2009, from a fleet of 120 TR1 North Sea vessels, 25 Scottish vessels have opted to use the 300mm Orkney trawl. This is currently only being used in the North Sea. Evaluating the impacts of these modifications in practice is difficult given that they are confounded by other external factors. Contrasting cod CPUE between the TR1 vessels with and without the Orkney trawl in principle should show differences, however, given the degree of variation in cod catches due to for example spatial distribution and individual vessel quota allocations, finding significant differences may be difficult. Contrasting the CPUE of the other species, such as monkfish, ling and megrim, may be more informative.

**Square mesh panels**

Square mesh panels have been used in many fisheries around Europe since the mid-1990's. The panels have been shown to reduce unwanted by-catch of juvenile fish, particularly haddock and whiting in fisheries targeting whitefish (Graham an Kynoch, 2001; Graham et al, 2003; O'Neill, 2004); and *Nephrops* fisheries (Briggs, 1992; Armstrong et al, 1998; Madsen et al., 1999; Krag et al, 2007). The impact square mesh panels have on cod catches are limited, some authors note significant difference in cod catches when using a 120mm square mesh panel while others note significant reductions in the retention of small cod. Drewery et al, (2010) investigated the impact of square mesh panels inserted 6 to 9m and 9 to12m from the codline and note that the gears caught significantly fewer cod than the control for lengths ≤ 32 cm and between 26 and 42 cm respectively, with retention estimated to be between 40 and 70%. Frandsen et al (2009) noted no significant effect on cod catches with a 120mm square mesh panel inserted 6-9m from the codline and Krag et al, (2008) actually noted an increase in cod catches when contrasting a 90mm and 120mm square mesh panel. In its evaluation of the square mesh panel in the Danish cod plan, STECF (2011) concluded that there is insufficient evidence to show that the use of the square mesh panel has contributed to a reduction in cod mortality. The differences are likely to be associated with the mesh size used in the panel, the panel position, and the lack of significant difference in cod retention. Work has shown that inserting the panel further back in the trawl can improve the efficiency (Krag et al, 2008) and the BACOMA panel, a square mesh panel inserted in the codend has been shown to regulate the size of cod catches (O'Neill et al, 2004).

Since 2009, all Danish TR2 vessels operating in the Kattegatt have been using 120mm square mesh panel.

**SELTRA 180**

Recent studies with square mesh panels constructed from large mesh sizes (e.g. 300mm) have shown significant reductions in cod catches in the *Nephrops* fishery when the panel is inserted inside a stable framework (Madsen et al, 2010) estimates that ~90% of the cod that enters the trawl will escape through the large meshes of the square-mesh panel. Subsequent experiments with a reduced panel mesh size (180 mm) conducted in the North Sea reduced the catch of cod by 67% in total. Denmark has proposed to use the SELTRA 180mm to obtain derogation to effort restrictions in the Kattegat. STECF (2011) noted that the estimates of reductions in cod catches are based on experimental data collected from research trials conducted in the North Sea. These demonstrated reductions in the order of 67% in number. The Danish authorities estimate that the mandatory introduction of this gear year round will result in a 44.2 reduction in the Danish partial fishing mortality for cod. This is based on the fact that the TR2 gear accounts for 66% of the catches and if the SELTRA 180 mm is applied year round the reduction in fishery impact (a proxy for fishing mortality) will be the proportion of cod fished by SELTRA times the effect of using SELTRA (66% out of 67% equal 44.2%). However, to maintain a viable flatfish fishery during the last quarter, it is proposed to use the SELTRA during the period January to September, where 78% of the cod landings from the TR2 segment take place. The estimated reduction in fishing impact is adjusted by 0.78 resulting in an estimated reduction in fishing pressure of 34.5%. This is based on the assumption that because the cod population structure in the trials area of the North Sea comprises greater proportions of fish >85cm, the effect of the gear when used in the Kattegat will be greater as catches from this area are smaller in size comprises mostly of fish in the range 20-40cm.. STECF notes that due to the absence of length frequency data from the two areas it is not possible to confirm that this is likely to be the case. STECF considers that the use of the SELTRA trawl is potentially an efficient tool to reduce fishing mortality on cod. However, for future evaluation of the effectiveness of the gear, STECF recommends that population independent selectivity parameters are obtained for both the current gear and SELTRA gear. This will allow for the estimation of what the catches of cod would have been without the

SELTRA gear by comparing the catch at length and the difference in the proportion at length between the current and new SELTRA trawl. Given that the use of the SELTRA trawl provides the basis of the majority of fishing mortality reductions for the future development of the plan, STECF considers that it is important that the use of the gear is fully implemented. The Danish plan intends that the new SELTRA gear will be implemented from July 1 2011 and in subsequent years from January 1 to September 30, coinciding with 78% of the cod landings associated with the TR2 fleet. During the period October 1 to December 31, the plan envisages the use of the 120mm square mesh panel. STECF reiterates that the 120mm square mesh panel is unlikely to have any significant effect on cod catches.

### *7.2.2. Review of spatial measures used under Article 13*

Denmark, the UK and Ireland have all introduced spatial and temporal closures to reduce cod catches. In Ireland, the authorities have introduced a seasonal closure (to all fishing gears) in ICES division VIa. The area bound by ICES statistical rectangle 39E3 (Figure 7.2.6) is closed from 1 October to 31 March to all Irish vessels, irrespective of fishing method. This period coincides with peak cod catches (Irish Statutory Instrument [Fisheries Management Notice No. 07 of 2011]).

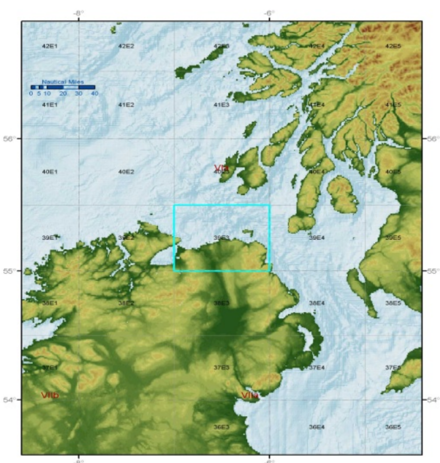


**Figure 7.2.6** Location of the Irish seasonal closure

Historically, over 40% of Irish cod landings are attributed to the closed area. For contrast, standardised CPUE rates observed from a dedicated survey conducted inside the closed area in 2009 were on average 26.8 kg/hr while CPUE rates estimated from observer trips outside the closure in 2009 were 0.015 kg/hr. The Irish authorities estimate that the introduction of the closure will have resulted in an approximate reduction in cod catches of 17%. In its assessment of the Irish submission made under the required reporting procedures to the Commission, STECF (2011) concluded that STECF considers it likely that the mortality due to the Irish fleet has reduced by at least the 17% required reduction.

All Danish vessels fishing in Kattegat with TR2 gear are subject to the joint Danish and Swedish seasonal and permanent area closures in Kattegat and the Northern part of the Sound. Area 1: The "black" area is closed during the 1st January-31st March (spawning season), except for fishery with selective gears with a very low catch of cod; The "black" area in the Northern Sound (”Kilen” or the triangle) is closed 1st February -31 March, except for fishery with selective gears; Area 2. The “orange” area is closed for all fisheries except fisheries with selective gears. Area 3: The “red” area is closed for all fisheries, including recreational fisheries (figure 7.2.7)

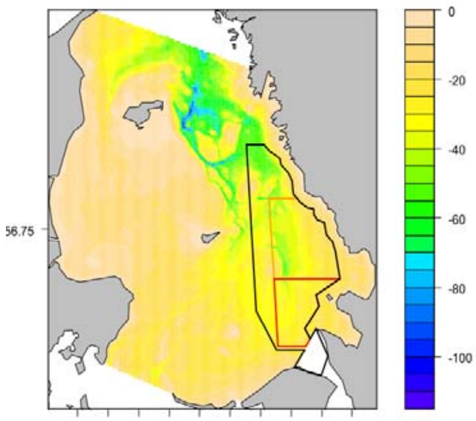



**Figure 7.2.7** Location of Danish and Swedish spatial closures in the Kattegat with Bathymetry 0-100 m depth (orange to blue).

Estimating the impact of closed areas in terms of reductions in fishing mortality is complex, given that trying to disentangle what vessels would have caught in the absence of the area closure and estimates the impacts associated with effort displacement is very difficult. The Danish authorities adopted a modelling approach, through the definition of CPUE contours based on fishery independent survey data across the entire area and overlaying the effort data based on VMS ‘pings’. While this is not predictive but estimates a relative change in cod catches from a situation if the closure had not been in place. The analysis shows that that fishing effort has been redistributed into areas of lower CPUE (based on modeled survey data). STECF (2011) concluded that the closures are likely to have resulted in redeployment of effort from areas with relatively high catch rates to areas with relatively lower catch rates. STECF (2011) also concludes that such redeployment of effort is likely to have resulted in a lower fishing mortality on cod in the Kattegat than would otherwise have occurred. STECF considers that the estimated reductions in fishing pressure of 24%, defined as the product of cod density and effort, provide the best proxy estimate for the expected local removals of vessels monitored with VMS.

## Scottish Real Time Closures

In Scotland, the provisions of Article 13c have been utilised in a co-management scheme known as Conservation Credits that rewards the adoption of cod avoidance behaviours and reduced cod catch rates by returning to fishermen some of their deducted effort. The scheme has two components, a compulsory element involving all vessels in a requirement to avoid Real Time Closures (RTCs) and an optional component comprising a schedule of alternative selective gears which attract varying degrees of effort buyback depending on the estimated reduction in cod catch (these options are discussed in the technical measures part of this section of the report). Annex 14 provides a fuller description of the scheme with a presentation of results so far.

RTCs were first employed in 2008 and the scheme was expanded rapidly in 2009 to 144 closures each 7.5nm x 7.5nm and lasting for 21 days. During 2010 165 closures were put in place and from July these were increased in size by 4 times based on emerging science on cod movements arising from tagging. The number of closures in each year is guided by the required adjustment in Scottish cod catch (in order to meet the requirements of the cod plan as assessed by ICES), the estimate of RTC performance (cod catch reduction) in previous years and the extent to which the stakeholders and managers wish to use RTC s to contribute to cod avoidance in the last couple of years the aim has been to use RTCs to achieve the first 20% reduction in fishing mortality. The position of closures is determined using landings data linked to VMS data with high LPUE areas subject to closure. Additional RTC closures arise from on board inspections and cod catch rates in excess of a pre-determined trigger level. A number of longer term seasonal closures, mainly focussed on expected spawning areas, were proposed by industry and have been operational from 2009.

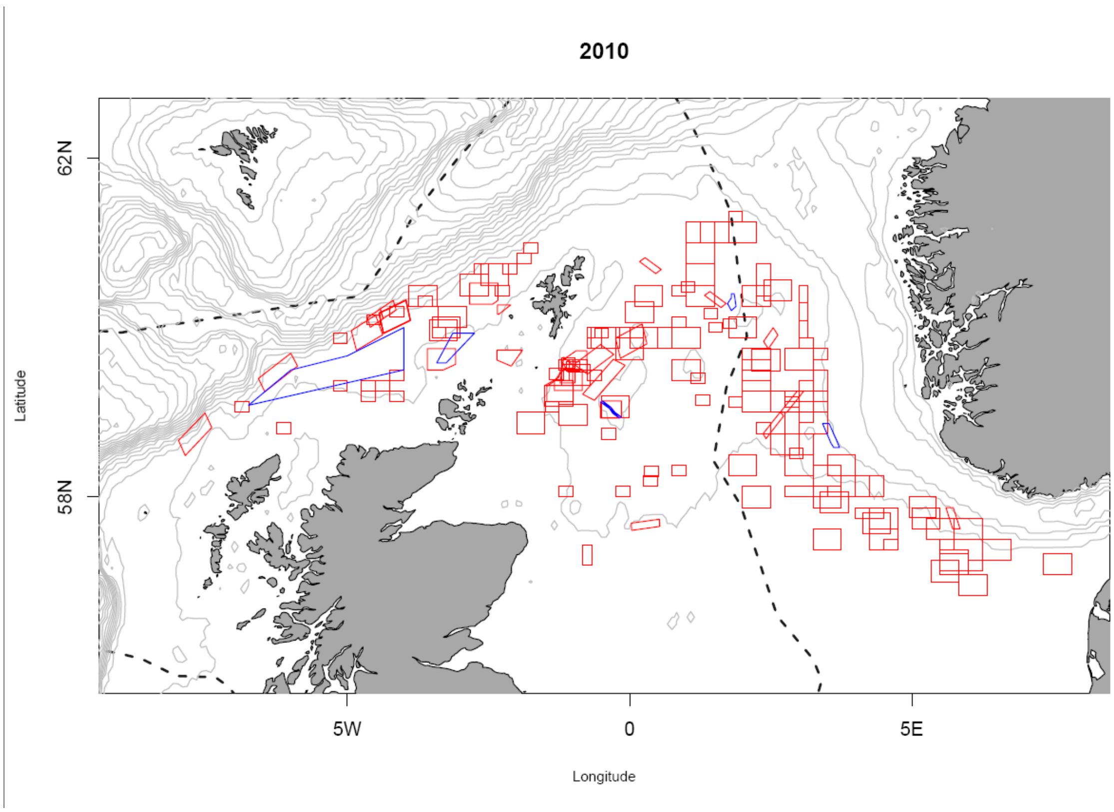



**Figure 7.2.8** Distibution of RTCs (red polygons) in 2010 under the Scottish Conservation Credits Scheme. Other closures directed at protecting cod are shown in blue.

Without the establishment of (impractically) large scale experiments, reliable evaluation of the contribution of RTCs is difficult principally because it is not possible to ascertain what would the fishing activity in an area have been in the absence of the closure. Nevertheless alternative indicators have been developed in Scotland to help determine whether RTCS are having an effect. The first of these relies on analysis of individual vessel movement data (for every vessel equipped with VMS) and the second computes aggregate landings of vessels operating in the vicinity of RTCS prior to closure and then compares this with their landings in the subsequent period while the closure is in place. Results from the first two years have been encouraging with significant movements away from cod abundant areas and also marked reductions in landings. These approaches so far only address the question of what happens to vessels directly impacted by

RTCs, whereas other vessels may choose to avoid areas of higher cod abundance altogether. A new approach examining the patterns of behaviour of all vessels over time is being developed and results are expected shortly.

Important in the evaluation process has been the recognition that numerous measures may operate in tandem such that ascribing any benefits to individual measures is not straightforward. To this end several ‘net effect’ approaches are being employed. Scotland has long recorded quite high discard rates, inconsistent with meeting targets for fishing mortality as expected in forecasts. In view of the improved quality of landings data, it is to be expected that meeting the targets of reduced catch will depend quite heavily on reducing discard rates significantly. During the period covered by Conservation Credits, discard rates in the TR1 gear (the main cod catching gear) have dropped from around 60% to 40% and then to about 24% in 2010. These data can be used alongside the monitored landings and results suggest that in the last couple of years, North Sea cod catches made by Scotland have broadly been in line with the ‘notional Scottish’ allocation of catch. Attempts have also been made to examine the partial Fs associated with the Scottish fleet. Analysis presented to the 2010 STECF Plenary demonstrated a 25% reduction in partial F associated with discards at a time when overall F apparently increased. STECF concluded that although the targets of the cod plan for 2009 had not strictly been met, there had been good progress and the measures should be strengthened and continue. Results of the 2010 RTCs and other measures will be examined by the Summer STECF plenary 2011.

### English Real-time Closures

As part of measures implemented by the UK Government to reduce fishing mortality on North Sea cod, the Marine Management Organisation (MMO) operates a Real Time Closure (RTC) scheme for all vessels under its administration, utilising article 13c to allocate additional days at sea. The scheme is designed to incentivise cod avoidance behaviour, with closures placed to compliment the closures introduced by Marine Scotland in the northern North Sea, but covering areas of the North Sea cod distribution south of 56oN in ICES areas IVb, IVc and VIId. Closed areas are identified based on report of high cod abundance by fishers; sampling by fisheries enforcement vessels which demonstrate catches of greater than 80 cod per hours tow; or, on the basis of historic Landings Per Unit Effort (LPUE) data, for areas where catch rates were shown to be high in corresponding periods during previous years.

During 2010 there were 5 seasonal closures (Figure 7.2.9), 3 of one month and 2 of four months in duration covering spawning locations for north sea cod; 105 real time closures (Figures 7.2.10 & 11), with 82 in offshore areas of 7.5 x 8.5 miles closed for 1 month, and 20 in inshore areas of 6.5 x 3.5 miles closed for 14 days, based on landing-per-unit-effort records; as well as 3 areas of 7.5 x 8.5 miles closed for 21 days for the protection of juvenile cod, identified on the basis of live sampling.

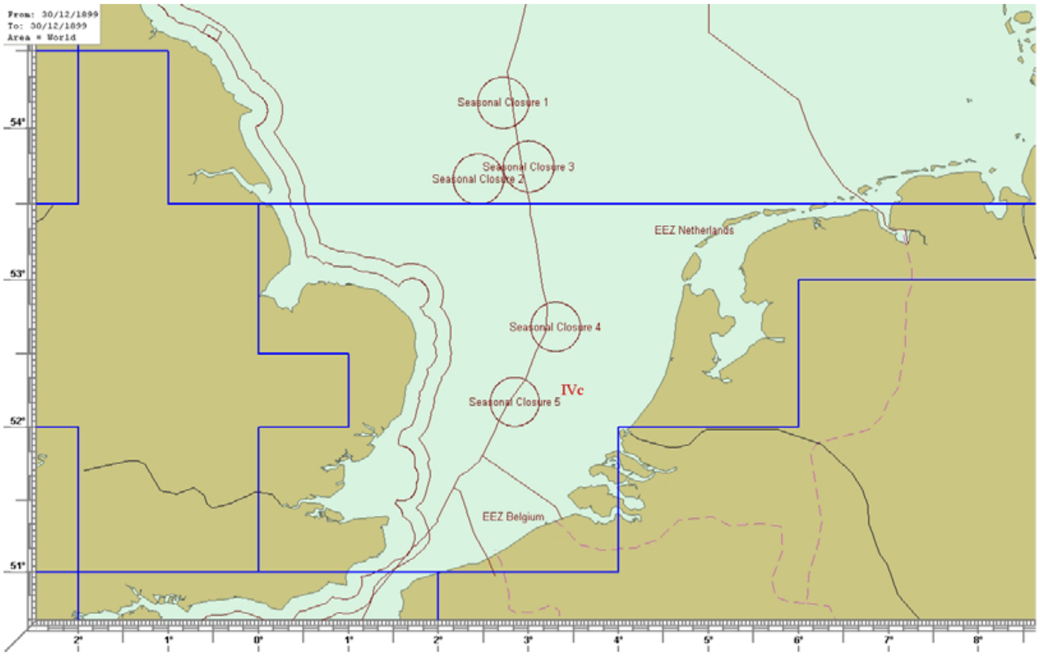
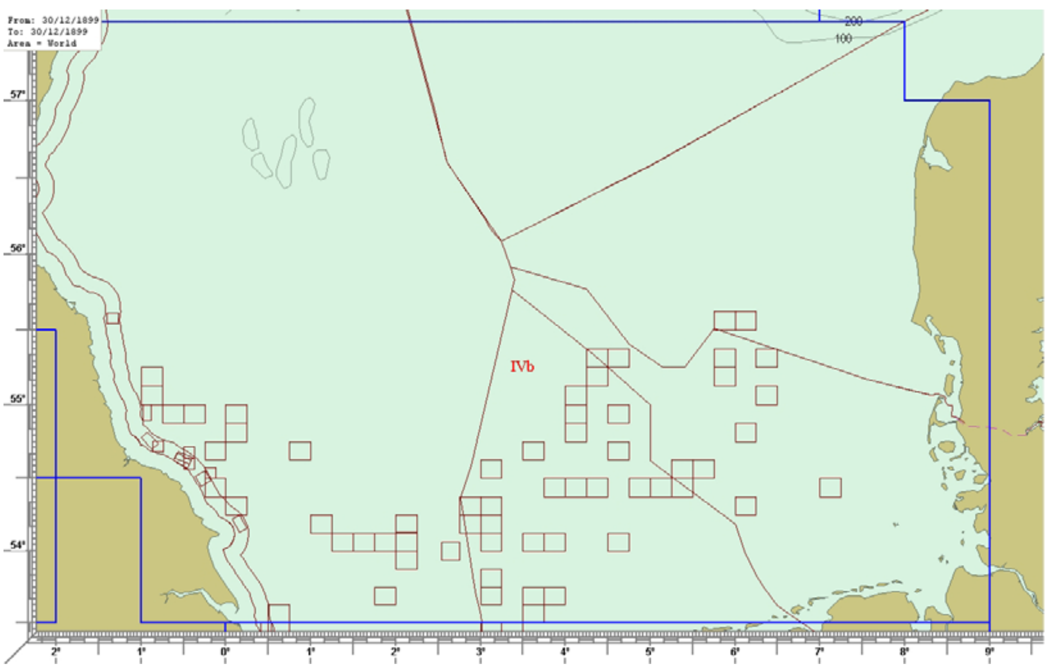
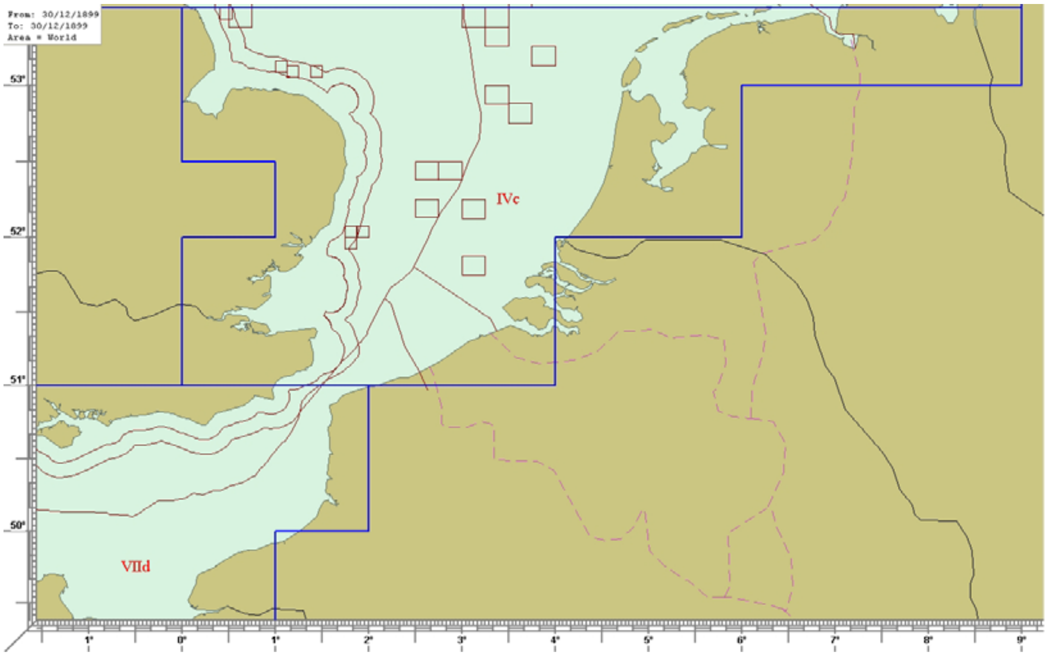



**Figure 7.2.9.** Seasonal closures implemented by UK Government during 2010.






**Figures 7.2.10 & 11.** Real Time Closures implemented by UK Government south of 56°N in 2010.

All English administered vessels using regulated gear as defined by the long-term management plan for cod are required to comply with all closures, as well as the closures introduced by other UK Fisheries Administrations, in order to receive an additional allocation of days at sea. The effectiveness of the scheme is currently being evaluated by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) under a DEFRA-funded R&D project MF1220 ("Improving the scientific basis for using real-time closures as a fishery management measure") which is utilising data from satellite-based Vessel Monitoring System (VMS) to build up a fine-scale picture of where vessels are fishing, and the amount of fish they are catching, as well as using biological information from extensive cod tagging studies undertaken by CEFAS to validate closure size and temporal extent given information on cod movements.

## 8. SOCIAL AND ECONOMIC EFFECTS OF THE PLAN

This section provides an overview of key changes in the characteristics, catch composition and financial performance of the major fleet segments prosecuting the North Sea Cod Fishery in the period 2006-2009. Detailed tables are provided in Annex 15. It has not been possible to examine the actual performance of the fishery against an estimated counterfactual and hence it is not possible with any certainty to attribute any of the observed changes to the North Sea Cod Plan.

Due to shortages of expertise no economic and social evaluations have been carried out for the other areas.

### 8.1. Data and fleet segment selection

The data for this analysis has been taken from the 2011 AER data call and covers the years 2006-2009. The initial data extraction included all fleet segments landing cod caught in the following FAO areas: 27.3a, 27.4, and 27.7d, which were taken as a proxy for the area covered by the North Sea Cod Plan. A proportion of the cod landings from area 27.3a is actually covered by other management plans and hence this approach overestimates to some extent North Sea activity. As there was no further spatial disaggregation possible and the impact on the overall results likely to be small, this approach is considered to be a reasonable second best.

A number of amendments were made to the dataset to provide a consistent and usable record across the required time period. The key change was to remove the Swedish data as changes in the definition of fleet segments from 2008 meant that a consistent time series could not be produced in the available time.

The remaining data contained details of 114 fleet segments, defined by Member State, fishing method and vessel length. There was a certain amount of missing data and a variety of approaches to reporting some aspects, for example effort, although there was greater consistency from 2008.

Of the 114 fleet segments, a subset was selected in order to enable more manageable and meaningful analysis. The most significant fleet segments in terms of North Sea cod were selected. Each of the selected fleet segments landed, on average, half a percent or more, by value, of the total North Sea cod landings (see table in Annex 15). Using this criteria, 19 fleet segments were selected from six Member States and using six fishing methods, including demersal and beam trawls and passive gears.

These 19 fleet segments caught between them, on average from 2006-2009, 90 per cent by value of all North Sea cod.

An alternative approach to fleet selection (e.g. as taken in the 2010 evaluation of the Baltic Cod Plan) would be to base it on cod dependency. This approach was tested and, using a dependency ratio of ten per cent as a threshold (i.e. taking all fleet segments for which North Sea cod represented 10 per cent or more of their total fishing revenues) narrowed the field to 21 fleet segments. The combined scale of these 21 segments only summed to 74 per cent of all North Sea cod landings by value and it was decided that using this approach was too restrictive compared to the alternative.

A brief comparison of the selected data (19 fleet segments) against the total population (114 fleet segments) shows, on average, that they comprised only a minority of the total vessels and total employment engaged in the North Sea cod fishery, but a significant majority of the total cod catch. The table in Annex 15 provides an indicative view of the selected fleet segments. Caution is required when considering the results of the full dataset (i.e. covering all 114 fleet segments) as there are a number of missing entries and inconsistencies which mean that those results are indicative and not completely robust. The data for the 19 selected segments, on the other hand, is largely complete and consistent with only a few exceptions, discussed below.

## 8.2. Missing variables

The data for the selected fleet segments was, in general, complete and consistent. There were a few exceptions and, where feasible, estimates were put in place to replace missing values. For example, some cost values were missing for some years for one of the UK and two of the Danish fleets and these were estimated using effort, landings and cost data for other years.

The two French fleet segments did not have a full set of associated data and were missing, in particular, effort data 2006-7 and landings data for 2008. It was not possible to estimate the missing variables in these cases.

## 8.3. North Sea Cod Dependence

As discussed above, the fleet segments selected for analysis were not the most cod dependent and, for many of them, North Sea cod provides only a small minority of their total fishing revenues. For almost all fleets, the importance of cod in total fishing revenues has declined over the period, sometimes significantly. The UK fleets are an exception to this with revenue from North Sea cod remaining relatively steady as a proportion of total income. For one of the UK fleet segments in particular, the 12-24m DFN, North Sea cod still provided the great majority of fishing revenues up to 2009 (see Annex 15 for details).

## 8.4. Capacity, Effort and Employment

Over the evaluation period 2006-9, fleet capacity has fallen by around a quarter, employment by just under a fifth and vessel numbers by over a third (see Table 8.1 below). The implied increase in average crew per vessel from three to four and the less than proportionate fall in fuel consumption both point to the unsurprising conclusion that the consolidation has been in favour of larger, more powerful vessels. The aggregate trends are clear, but there is considerable variation at the level of fleet segments. For example, some of the UK and Netherlands fleet segments experienced steady or even increasing vessel numbers and employment whereas many of the Danish fleet segments showed declines substantially greater than the average.

Alongside the fall off in vessel capacity, effort has also declined, by around a third and slightly more in the North Sea than elsewhere. But effort per vessel has increased implying that the fleet consolidation may have had some benefits for the remaining vessels.

**Table: 8.1** Selected fleets, total: capacity and employment

| | 2006 | 2007 | 2008 | 2009 | % change 2006-09 | average per vessel 2006 | average per vessel 2009 |
|---|---|---|---|---|---|---|---|
| Employment (FTE) | 9524 | 8821 | 8144 | 7764 | -18% | 3 | 4 |
| Fleet GT | 281,827 | 262,592 | 258,520 | 221,921 | -21% | 78 | 114 |
| Fleet KW | 954,454 | 877,757 | 821,563 | 697,729 | -27% | 263 | 359 |
| Fleet(number) | 3659 | 3409 | 2534 | 2381 | -35% | | |
| Fuel Cons (litres) | 657,049,645 | 675,702,936 | 589,283,562 | 558,807,903 | -15% | 180,806 | 287,453 |
| Implied fuel price (euro/litre) | 0.45 | 0.44 | 0.56 | 0.38 | | | |

## 8.5. Financial performance

In line with falling fleet capacity and effort, all non-fixed costs have declined since 2006 (NB all financial data is in current prices. Costs are provided as totals for each fleet segment and do not differentiate where they were incurred i.e. it is not possible to isolate costs related specifically to North Sea activity). Crew costs, variable costs and fuel costs have all declined markedly. Total costs are reported as falling by over a third. Over the same period total fishing revenues have also fallen, but proportionately less than costs, with a decline of 12 per cent, implying that aggregate fishing profitability has increased. Landings and associated revenues from North Sea cod have fallen significantly (36 per cent) while prices have remained largely unchanged (not counting for inflation). Again, the aggregate view masks considerable variation at the level of fleet segment.

While costs and revenues are falling at an aggregate level, the data suggests that both are increasing at a vessel level, a view supported by the increase in per vessel effort levels. Overall, costs per unit of effort have declined and revenues per unit of effort have increased. This suggests, plausibly, that it has been the most cost-inefficient participants which have exited the fleet while relatively more efficient vessels have remained engaged and have, up to 2009, been able to increase their activity.

While the data on costs may be indicative, it is not definitively robust and analysis at a fleet segment level is enough to raise suspicions about the quality of the results being reported. For example, for a number of fleet segments, the reported operating costs (i.e. sum of fuel, crew, repairs and other variable costs) vastly exceed the fishing revenues for each year implying unfeasibly large and sustained negative operating profits. Further detail is in Annex 15.

### 8.6. Evaluating the Plan

The data analysis reviewed above and Annex 15 provides some indications of trends in the composition and performance of the various fleets engaged in the North Sea Cod Fishery and affected by the Long Term Management Plan for Cod. What has not been possible is to attribute any of the observed changes directly to the Cod Plan – in that sense this is very much an evaluation of the fleet in recent years – and economic data has only been available for the first year of the revised Plan, 2009 - rather than an economic evaluation of the Plan itself.

Some of the steps to allow a meaningful evaluation of the Cod Plan have now been undertaken. In particular, a counterfactual baseline has been estimated, illustrating the likely TACs and effort had no Plan been put in place from 2009. This is discussed in further detail in Section 9.1 below. The baseline estimates show that cod TAC with the Plan in 2009 is slightly higher than 'no plan' and around ten per cent higher with the Plan in place in 2010 and 2011. In all years 2009-11 effort is lower with the Plan than without.

Deriving the revenue effect of the additional cod TAC is straightforward if it is assumed that the changes are insufficiently large to induce significant effects on price and that all of the TAC is used – the suggested difference in TAC for 2009 implies an additional EUR1.3m in North Sea cod revenues. From a financial performance perspective profit is a more useful metric, but, as noted above, the existing cost data may not be reliable and hence estimates of the impact on profitability will prove more difficult.

The more complex task in evaluating the Plan against its baseline, and one which requires a separate effort, is to estimate the impact of effort restrictions. The extent to which effort restrictions are binding, for which fleet segments and in respect of which stocks is not altogether clear. Undoubtedly effort in the North Sea would be higher without the Plan, the more so as the incremental impacts of effort restrictions take effect with each successive year. The resources to conduct this sort of analysis have not been available and it would yield more useful results if a longer period of analysis was possible i.e. when data for 2010/11 is available.

In addition to understanding the economic impacts of the headline TAC and effort changes, a more thorough evaluation will also be required to unpick the particular consequences of the various approaches undertaken under Article 13 and which, at the level of individual fleet segments, may have had significant effects.

## 9. THE ADDED VALUE OF THE MULTI-ANNUAL PLAN

### 9.1. Generation of a Baseline

The consequences of not having the 2008 agreed plan for four cod stocks in Kattegat, North Sea, West of Scotland and Irish Sea was evaluated by comparing the TACs and effort from 2008 onwards assuming that the management would follow the approach laid out in the annual policy documents from the Commission, the detain is given in Annex 16. In general the North Sea stock is expected to follow the clause based on a 'know state of the stock' and the stock being evaluated as 'outside safe biological limits'. For the three other stocks no assessment was available for most years so it is assumed that STECF would follow the general ICES advice for 'zero catch', and that the state of the stock would be defined as 'unknown'.

## 9.2. Outcome TACs and Effort:

The TACs set under the plan regulation, the new TACs set under the policy document if there was no plan are given in Table 9.1. The tonnages of legal landings under the plan and under 'no plan' are give in columns 3 and 7 respectively. Column 10 gives the change in landings expressed at a ±% of the TAC originally set under the plan. For Effort the no plan option is likely to have been less restrictive. Column 8 gives an indication of the Commission policy in the absence of the plan. For West of Scotland, TAC in 2009 appears to have been set in error as the reduction is almost twice that expected and in the subsequent year there was no reduction. Thus the no plan option may or may not have suffered from the same issue. If not the TAC in 2009 would have been higher. For subsequent years it is lower. For NS cod no effort restrictions would have applied, this might have had a number of consequences.

- Vessel costs might have changed as vessels fished for longer but might have used slower steaming speeds, or reacted in a variety of ways to use the greater effort allowed

- If there were fishing opportunities on other species (untaken TACs) these might have been taken.

For the other cod stocks there would have been a requirement to reduce effort but the amount was not specified.

## 9.3. Outcome catches and stock:

It is more difficult to estimate what might have happened to catch; there are several considerations (see Annex 16). Firstly it is concluded there is no measurable influence of the TACs set under plan/no plan on catches. It is considered that in this context 2011 may be different, particularly for the Kattegat with a more dramatic change in TAC.

- For effects of effort these may be different by area.

- For Kattegat we have no estimate of removals so it is not possible to estimate catch or change in catch between no plan / plan

- For West of Scotland and Irish Sea we have no basis to determine what the effort change would be under 'no plan' and even if there was a change what this change would have done to altered the catch.

- For NS the situation is complex. For 2008 and 2009 under the plan the ratio of removals to TAC decreases slightly as headline effort declines under the plan (Table Under 'no plan' there could have been no effort reduction. Its unknown what would have happened to catch but as removals were at 2.6 times the TAC it does not seem to be convincing that the headline effort rate is strongly controlling removals. For 2010 the ratio of removals to TAC is not know yet. For NS it is possible that 'no plan' would have resulted in higher F in 2009/2010 but not in a direction to change the state of the stock from 'below Blim' and probably not enough to change average catch over the two years by much. Thus the state of the stock might have been worse but is unlikely to be better even though TACs would have been smaller.

## 9.4. Economic and other potential impacts of no plan

Detailed work to bring the findings of the 'no plan' analysis into the economic evaluation has not as yet been conducted. For Irish Sea there was no difference. For West of Scotland the situation is confused with apparently over reduction TAC in 2009 and subsequent correction in 2010 with a small change for 2011. Given the complete lack of a link between TAC and catch in West of Scotland the differences are difficult to disentangle. For Kattegat the most recent larger reduction in TAC in 2011 would expect to result in decrease profit opportunities. For the North Sea the situation is also complex. The direction of financial impacts arising from the TAC and the effort changes is straightforward – positive TAC changes increase profit opportunities, reduced effort changes reduce them. The balance of change, however, cannot be prejudged in advance of a proper analysis. The indications from the analysis of effort imply that effort restrictions have become steadily more effective in practice as initial headroom has been eroded. The effort restrictions have tended to become binding on non-cod stocks first and hence the gains in cod TAC have been available in full. The balance of short run costs and benefits for affected fleet segments depends, then, on the relative scale of the two offsetting impacts, the increased cod TAC and the reduced effort available for non-cod opportunities. The balance is as yet unknown and will be different on a fleet segment basis, depending, for example, on the relative importance of cod compared to the importance of other stocks where effort restrictions are binding.

**Table 9.1** Comparison of TAC and nominal effort changes under the 2008 plan and the TACs and changes in effort under 'No plan', see text for details of assumptions. The changes are summarized as the ratio of (no plan/plan) landings Also included is a column that indicates what we conclude might change in catch and a comment concerning the basis for the TACs set where this is not obvious.

| Stock | Year | Under Plan | | | Under no plan | | | Realized Fishery Ratio Removals /TAC | No Plan/ Plan | | Comment on outcome or basis of plan |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Applied TAC | %change from previous year | Effort Reduction Approx# | %change from previous year | TAC (max) | Effort Reduction | | % change in allowed landings | Effect on catch | |
| Kattegat | 2008 | 673 | | | | | | Unknown | | | |
| | 2009 | 505 | -25% | -25% | -25% | 505 | reduction unknown | Unknown | No difference | Unquantifiable | |
| | 2010 | 379 | -25% | -25% | -25% | 379 | reduction unknown | Unknown | No difference | Unquantifiable | |
| | 2011 | 190 | -50% | ?? | -25% | 284 | reduction unknown | Unknown | 50% increase | | Basis of 50% unknown |
| West of Scotland | 2008 | 402 | | | | | | 11.5 | | | |
| | 2009 | 240* | -40% | -25% | -25% | 302 | reduction unknown | 14.9 | +25% | Unquantifiable | |
| | 2010 | 240 | 0% | -21% | -25% | 227 | reduction unknown | | 6% reduction | Unquantifiable | 25% plan reduced to 21% change |
| | 2011 | 182 | -24% | -24% | -25% | 170 | reduction unknown | | 7% reduction | | 25% plan reduced to 24% change |
| Irish Sea | 2008 | 1199 | | | | | | 1.5 | | | |
| | 2009 | 899 | -25% | -25% | -25% | 899 | reduction unknown | 1.2 | No difference | Unquantifiable | |
| | 2010 | 674 | -25% | -25% | -25% | 674 | reduction unknown | | No difference | Unquantifiable | |
| | 2011 | 506 | -25% | -25% | -25% | 506 | reduction unknown | | No difference | | |
| North Sea | 2008 | 25290 | | | | | | 3.3 | | | |
| | 2009 | 34590 | +37%# | -25% | +35% | 34015 | No effort change | 2.6 | No difference | Unquantifiable | 30% reduction in F |
| | 2010 | 40300 | +17% | -10% | +5% | 36320 | No effort change | | 10% reduction | Unquantifiable | 30% reduction in F |
| | 2011 | 32241 | -20% | -10% | -20% | 29056 | No effort change | | 10% reduction | | 20% reduction in TAC |

#TAC uncertain due to unknown way of allocation of VIId part of NS stock TAC from combined TAC IIVb-k TAC , # effort reduction is headline effort not taking into account any exemptions under Articles. * Possible error in setting and then subsetting larger area TAC to West of Scotland

## 10. PERFORMANCE EVALUATION OF THE PLAN

Based on the above analyses the Workshop came to the following conclusions and observations

### 10.1. Effectiveness

*• What have been the immediate results and medium term impacts for the stock addressed by the multi-annual plan? Have the objectives of the plan been achieved?*

Given that the plan is only into place for 3 years, it is premature to conclude on the medium term impact

- A full analytical assessment is available only for North Sea cod. Objectives have not been met in terms of F. F has declined and SSB has increased prior to introduction of plan. There have been continued but minor reductions in F and increases in SSB since the introduction of the plan. Progress towards target is hindered due to TAC and effort regime failing to constrain removals.

- Of the other stocks, there are assessments but these are only indicative of trends in F and biomass. For the West of Scotland and Irish Sea fishing mortality is very uncertain but total mortality remains very high. In the Kattegat, there is a high degree of uncertainty in F. Biomass levels are estimated to be well below Blim

- Objectives in terms of F reductions do not appear to have been met in WoS, Kattegat and the Irish Sea, but, while mortality is considered to be well above the target objectives in line with the current plan, the exact level of F is unknown due to uncertainties in mortality estimates arising from *inter alia* unallocated removals, catches in excess of TAC and other sources of mortality. ,

- Medium term simulations based on the current rate of change per year in F suggest that for North Sea, Irish Sea and West of Scotland cod stocks it is unlikely that following the current regime F will reduce sufficiently to reach F=Fmsy by 2015. Currently it is not possible to evaluate the likely success in terms of F by 2015 for Kattegat cod.

*• What have been the immediate results and medium term impacts of the multi-annual plan on the environment and the ecosystem, for example by-catch, discards, non-target species?*

- Reductions on discards, on commercial and non-commercial species, associated with Article 11 and Article 13 (technical measures) have been significant when used in some areas (e.g. North Sea).

- Some technical measures have significantly reduced commercial by-catch (e.g. *Nephrops* fisheries with grids have become single-species fisheries).

- Reported landings in most areas are in line with the plan, but due to high discards in some areas, catches are well in excess of TAC e.g. West of Scotland

- Effort displacement may have had a negative impact.

*• Have there been any side effects resulting from the plan? (for example, changes in behaviour that affect other fisheries, or environmental consequences, changes in the market).*

- Various fleets have committed themselves to use more selective gear (Article 11 or Article 13) or to real time closures (Article 13) or to fish outside the distribution area of cod (Article 11).

*• Has the implementation been affected by external factors such as global change, ecosystems effects, or other fisheries?*

- Positive responses in biomass may have been hindered by external factors (e.g. seal predation on the West of Scotland, Pope and Holmes 2008).

## 10.2. Utility

*• What trends in fleet capacity (kW or GT) would have been expected from the implementation of the plan? What trends were actually observed?*

- Substantial decline in effort, although much of this occurred before introduction of the current cod plan, and continued decline at a lower rate or in some cases leveling out.
- Otter trawl gears contribute the highest effort amounts, with the importance of TR1 and TR2 gears varying between areas. Beam trawl (BT2) effort is also very significant in the North Sea
- The extent of unregulated effort varies between areas. However, this is associated with minimal cod catches
- Effort associated with Article 11 is relatively low in all areas,
- Effort associated with Article 13 ranges from 25% to 75% between areas

*• Are the fleets affected by the multi-annual plan in a situation of overcapacity?*

- Currently we are unable to estimate the appropriate capacity for these fleets due to the complexity of the species mixtures and the shortage of economic data.

*• Did the multi-annual plan contribute to adapting the fleet capacity to the fishing possibilities resulting from the multi-annual plan?*

- It was not possible from the evaluations available to indicate to what extent the plan alone was responsible for changes in fleet capacity (fuel prices and fish prices have recently been volatile).

## 10.3. Efficiency (cost-effectiveness)

The costs of this plan in terms of for example employment, gross revenue of the fleet

- At a fleet and vessel level, reductions in effort may not necessarily result in commensurate reduction in revenue as business will be incentivized to maximize revenue from available effort.
- Costs at a fleet level have fallen in line with effort, but have increased at an individual vessel level.
- Meta analysis can mask significant changes at an individual business level. Therefore, to understand the implications at an individual business level more detailed analysis would be required.
- According to a sociological study, based on a small sample of interviewed fishers, employment has gone down. Additionally results from economic studies show that employment has fallen.

Effects on the broader industry (processing, transporting, auxiliary)

- Implicit in the reduction in capacity, there are likely to have been negative consequences for the broader industry, although there are no specific documented cases which can be attributed to the Plan.

Economic benefit/loss during the period of implementation

- Analysis of changes in profitability at the level of fleet and vessel has not been possible due to concerns over the quality of the cost data. There are indications that revenue per vessel may have increased while falling at the fleet level, but it is not possible to attribute these changes to the Cod Plan.

Indicators

- The economic indicators were only sufficient to describe changes over the period of analysis. It has not been possible to attribute any of those observed changes in the indicators to the multi-annual plan and hence they are not sufficient, on their own, to enable a robust evaluation.

### *Sustainability*

Sustainability of the plan relative to the initial impact assessment?

- From a biological perspective all the cod stocks covered by the plan are currently likely to have an SSB below Blim. However, for North Sea and West of Scotland cod SSB has increased in recent years.
- Fishing mortality has not declined as envisaged by the plan
- The long run (i.e. taking account of stock effects) economic sustainability of the plan cannot be judged at this stage.

## 11. CONCLUSIONS

Based on the answers to previous questions, the Workshop draws the following global judgement on the plan

With regards to the utility and sustainability of the multi-annual plan and its contribution to the objectives of the Common Fisheries Policy.

- The plan has not controlled fishing mortality as envisaged.
- Mortality of some other species such as haddock and whiting may have declined to levels consistent with CFP objective in some areas, and maybe partly due to cod plan.
- The short run economic impacts of the multi-annual plan are not clear and will depend on the balance of benefits resulting from increased cod TAC and costs resulting from reduced effort. The impact on long run economic sustainability will also depend on the stock effects of the plan which at this stage are unknown.

Success in achieving its stated objectives

- The plan has not achieved its stated objectives.
- In all of the stock areas the total recorded effort by the gears for which cuts applied decline slightly, but did not decline, in 2009 and 2010, in line with the reductions according to the plan.
- There have been positive contributions under Article 13c which appears to provide benefits towards achieving the cod plan targets. Article 13 allows a flexible, locally tailored response which should provide better governance with measures based directly on landings and discards. Notable effects are: redistribution of effort away from higher abundance in Kattagat; discard reductions in the northern North Sea by TR1 vessels; the use of more selective gears, and cod avoidance through real time closures. However, the verification aspects of Article 13 are too complex.

Specific indicators that would be useful for a future evaluation of this multi-annual plan

- Fully documented catch of cod by vessel

Additional data that should be collected in the future to help in evaluating the multi-annual plan

- Economic data linked to vessels operating specifically under the cod plan by Article along with documented catch of cod by vessel

Other plans this plan should be linked to

- The plan would benefit from linking to plans for *Nephrops* and haddock, whiting, saithe sole and plaice in the North Sea.

Any future revision should consider the following:

- Substitute alternative metrics for TAC (as Total Allowed Landings) or the current effort regime to regulate catches. These have been unable to adequately control cod removals. Reliance on these control instruments is a core weakness in the plan.
- The HCR in the plan is overly reliant on annual estimates of F which are either absent, inaccurate or imprecise. Consideration should be given to multiannual metrics for informing decisions.
- The lack of analytical assessments in WoS, Irish Sea and Kattegat preclude the application of the HCR. Therefore different metrics are needed for the application of the HCR.
- Short term forecast has been available for North Sea cod and has not been available for other cod stocks.
- Short term forecasts show bias in estimating SSB and F; specifically, SSB is overestimated and F is underestimated; by comparison removals were estimated less biased
- Single-stock LTMPs were designed without consideration of the fishing opportunities for other species. Mixed fisheries simulations give an indication of the potential implementation error in North Sea cod advice, with actual F being higher than stipulated in the LTMP if there is continued fishing for other species with higher TACs as well as of the potential overcatch or underutilization of TACs.
- It is concluded that we should not necessarily expect fishing mortality to follow trends in fishing effort.
- Exemptions through Article 11 require low cod catches. These exemptions should only be approved when the fishing activity is deployed outside the distribution area of cod, or if deployed within the cod distribution area, when the used fishing gear is designed and confirmed to minimize cod catches.
- Cod catches lower than a certain % (as in Articles 11 and 13.2b) can still contribute significantly to overall cod mortality if overall catch or effort is high or when abundance is low. This is a fundamental flaw in the design of the plan. A system based on proportion of total expected cod outtake from the whole fishery would be more appropriate.
- Basing monitoring on percentage composition (as in Articles 11 and 13) provides a disincentive to improve selectivity for other species as reducing overall catch can increase the percentage of cod even if cod catches are constant.
- The starting baseline used in Article 12 of the plan is derived from the average of either 2004-2006 or 2005-2007 depending on MS choices. For the North Sea this means that allowed effort in the first year of the plan (Effort 2009 = 75% of the baseline) could be higher than 75% of effort in the preceding year (2008). Because the stipulated F reductions of 25% are relative to 2008, this resulted in effort reductions not being in line with F reductions. For the other stocks the percentages may have been different, but for the same reason the effort reductions were not in line with the F reductions.
- Differences have occurred in the respective methodologies used to calculate effort from the reference years and those in the reported consumption of effort within the plan. This will have resulted in higher then intended effort.
- Clear and unambiguous phrasing of the elements of regulations will make compliance more transparent and potentially more reliable.

## 12. PREPARATION FOR SCOPING IA

In preparation for the Impact Assessment of a revised plan, a scoping meeting will be required. In order for scientific advice to be given, Commission and MSs need to indicate in that meeting a range of aspects

- The regulatory measures they might be prepared to implement, and specifically those they are not willing to consider, to focus available expertise in the most productive areas.
- Specific objectives with timescales and if there are multiple objectives some idea of the tradeoffs.

- If catch quotas are to be considered for some fleets, those with expertise in compliance should be requested to attend to discuss compliance for catch quotas, likely errors and uncertainties.

Observers: The following discussion is not intended as a criticism rather as observation to improve for the process for the future. There was considerable difficulty in managing numbers of participants to the meeting, in particular observers. Part of the problem is the *ad hoc* approach to organising the meeting. While the overall numbers were supposed to be limited to 40, due to the room size, with 28 invited experts this would have implied 12 Commissions staff and observers. While some observers were very careful to register early, others seemed to feel that registering was not their responsibility, and even some Commission staff registered very late. In the end around 47 people were invited to come, though many observers were part time. These increased numbers were the result of imbalance in participation/notification occurring over time. One MS wished to send an observer notifying just two days before the meeting. It would be very helpful if STECF had a clear policy on who should be notified of meetings and this was formally communicated to all those involved. However, such a policy requires clear and early preparation of ToR and attendance lists. The need to define ToR implies the Commission having a clear idea of its policy and priorities significantly earlier than has previously been the case.

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## 14. References


Armstrong, M.J., Briggs, R.P., Rihan, D., 1998. A study of optimum positioning of square-mesh escape panels in Irish Sea *Nephrops* trawls. Fish. Res. 34, 179–189.

Bastardie, F., Nielsen, J.R., Ulrich, C., Egekvist, J., and Degel, H. 2010. Detailed mapping of fishing effort and landings by coupling fishing logbooks with satellite-recorded vessel geo-location. Fisheries Research, 106: 41-53.

Baudron, A., Ulrich, C., Nielsen, J. R., and Boje, J. 2010. Comparative evaluation of a mixed-fisheries effort-management system based on the Faroe Islands example. – ICES Journal of Marine Science, 67: 1036–1050.

Beutel, D., Skrobe, L., Castro, K., Ruhle Sr., P., Ruhle Jr., P., O'Grady, J., Knight, J., 2008. Bycatch reduction in the Northeast USA directed haddock bottom trawl fishery. Fisheries Research 94 (2), 190–198.

Briggs, R.P., 1992. An assessment of nets with a square mesh panel as a whiting conservation tool in the Irish Sea *Nephrops* fishery. Fish. Res. 13, 133–152.

Campbell, R., Harcus, T., Weirman, D., Fryer, R.J., Kynoch, R.J., O'Neill, F.G. 2010. The reduction of cod discards by inserting 300 mm diamond mesh netting in the forward sections of a trawl gear. 2010. Fisheries Research, 102 pp 221-226

Dickey-Collas, M., Pastoors, M. A., and van Keeken, O. A. 2007. Precisely wrong or vaguely right: simulations of the inclusion of noisy discard data and trends in fishing effort on the stock assessment of North Sea plaice. ICES Journal of Marine Science, 64: 1641-1649.

EU 2004. Council Regulation (EC) No 423/2004 of 26 February 2004 establishing measures for the recovery of cod stocks

EU 2008. Council Regulation (EC) No 1342/2008 of 18 December 2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing Regulation (EC) No 423/2004.

Frandsen, R.P., Holst, R., Madsen, N. 2009. Evaluation of three levels of selective devices relevant to management of the Danish Kattegat-Skagerrak *Nephrops* fishery. Fisheries Research, pp 243-252

Gerritsen H., Lordan, C. 2011. Integrating vessel monitoring system (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES Journal of Marine Science, 68(1): 245-252.

Graham, N., Kynoch, R.J., 2001. Square mesh panels in demersal trawls: some data on haddock selectivity in relation to mesh size and position. Fish. Res. 49, 207–218.

Graham, N., Kynoch, R.J., Fryer, R.J., 2003. Square mesh panels in demersal trawls: further data relating haddock and whiting selectivity panel position. Fish. Res. 62, 361–375.

Graham, N., O'Neill, F.G., Fryer, R.J., Galbraith, R.D., Myklebust, A., 2004. Selectivity of a diamond mesh cod-end and the effect of inserting a grid or a square mesh panel. Fisheries Research 67, 151–161.

Harley, S.J., Myers, R.A. and Dunn, A., (2001). Is catch-per-unit-effort proportional to abundance? Can. J. Fish. Aquat. Sci. 58: 1760–1772.

ICES 2011 Report of the ICES WKROUNDMP 2011 / STECF EWG 11-07. Evaluation and Impact Assessment of Mangement plans pt II. ICES CM 2011/ACOM:56

ICES WGBFAS. 2011. Report of the Baltic Fisheries Assessment Working Group. ICES CM 2011/ ACOM: xx

ICES WGCSE. 2010. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE). ICES CM 2010/ACOM:12

ICES WGCSE. 2011. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE). ICES CM 2011/ACOM:xx

ICES WGNSSK. 2011. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 2011/ ACOM xx

ICES WKROUND. 2009. Report of the Benchmark and Data Compilation Workshop for Roundfish (WKROUND). ICES CM 2009/ ACOM:32

Jákupsstovu, S. H. í, Cruz, L. R., Maguire, J-J., and Reinert, J. 2007. Effort regulation of the demersal fisheries at the Faroe Islands: a 10-year appraisal. ICES Journal of Marine Science, 64: 730–737.

Kelly, C. J., Codling, E. A., and Rogan, E. 2006. The Irish Sea cod recovery plan: some lessons learned. ICES Journal of Marine Science, 63: 600-610.

Kraak, S. B. M., Buisman, F. C., Dickey-Collas, M., Poos, J. J., Pastoors, M. A., Smit, J. G. P., van Oostenbrugge, J. A. E., et al. 2008. The effect of management choices on the sustainability and economic performance of a mixed fishery: a simulation study. ICES Journal of Marine Science, 65: 697-712.

Krag, L.A., Frandsen, R.P., Madsen, N., 2008. Evaluation of a simple means to reduce discard in the Kattegat–Skagerrak Norway lobster (*Nephrops* norvegicus) fishery: commercial testing of different codends and square-mesh panels. Fish. Res. 91, 175–186.

Madsen, N., Moth-Poulsen, T., Holst, R., Wileman, D., 1999. Selectivity experiments with escape windows in the North Sea *Nephrops* (*Nephrops* norvegicus) trawl fishery. Fish. Res. 42, 167–181.

O'Neill, F.G., Graham, N., Kynoch, R.J., Ferro, R.S.T., Kunzlik, P.A., Fryer, R.J., 2008. The effect of varying cod-end circumference, inserting a 'flexi-grid' or inserting a Bacoma type panel on the selectivity of North Sea haddock. Fisheries Research 94, 175–183.

Piet G.J., van Hal R., Greenstreet S.P.R. 2009. Modelling the direct impact of bottom trawling on the North Sea fish community to derive estimates of fishing mortality for non target species. ICES Journal of Marine Science, 66: 1985-1998.

Poos J.J., Rijnsdorp A.D. 2007 The dynamics of small scale patchiness of plaice and sole as reflected in catch rates of the Dutch beam trawl fleet and its implications for the fleet dynamics. Journal of Sea Research, 58: 100-112.

Pope, J. G., and Holmes, S. J. 2008. Length-based Approaches compared to Age-based Approaches to Determining the Significance of Grey Seal Feeding on Cod in ICES Division VIa. ICES CM 2008/F:08.

Rijnsdorp, A.D., Daan N., Dekker W. 2006. Partial fishing mortality per fishing trip: a useful indicator of effective fishing effort in mixed demersal fisheries. ICES Journal of Marine Science 63: 556-566.

STECF 2010. Scientific, Technical and Economic Committee for Fisheries (STECF) – 35th Plenary Meeting Report. (eds. Casey J. & Doerner H.). 2010. Publications Office of the European Union, Luxembourg, EUR 24626 EN, JRC61940, 214 pp.

## 15. LIST OF BACKGROUND DOCUMENTS

Background documents are published on the meeting's web site on: XXXXXXXX

List of background documents:

1. EWG-11-07 – Doc 1 - Declarations of invited and JRC experts.

## Annex 1 Review of Article 11

Norman Graham Marine Institute Ireland

Article 11(2) of Council Regulation 1342/2008 of 18 December 2008 (long-term management plan for cod), makes provision for The Council, acting on a Commission proposal and on the basis of the information provided by Member States and the advice of STECF, to exclude certain groups of vessels from the effort regime, provided certain conditions are met. Following the adoption of EC regulation 1342/2008, STECF were requested to evaluate each individual request to assess whether sufficient data had been presented so as to determine whether the conditions laid out were being fulfilled. Article 11.2 of the regulation stipulates that:

> *11.2 The Council may, acting on a Commission proposal and on the basis of the information provided by Member States and the advice of STECF referred to in paragraph 3, exclude certain groups of vessels from the application of the effort regime provided that:*
>
> > *(a) appropriate data on cod catches and discards are available to allow STECF to assess the percentage of cod catches made by each group of vessels concerned;*
> >
> > *(b) the percentage of cod catches as assessed by STECF does not exceed 1.5% of the total catches for each group of vessels concerned; and*
> >
> > *(c) the inclusion of these groups of vessels in the effort regime would constitute an administrative burden disproportionate to their overall impact on cod stocks*
>
> *If STECF is not in the position to assess that these conditions remained fulfilled, the Council shall include each of group of vessels concerned in the effort regime.*
>
> *11.3 Member States shall provide annually appropriate information to the Commission and STECF to establish that the above conditions are and remain fulfilled in accordance with the detailed rules to be adopted by the Commission.*

Since the introduction of the regulation STECF has evaluated 34 proposals from France, Spain, UK (Scotland, Northern Ireland, Isle of Mann, England), Sweden, Ireland, Poland and Germany. Of the only 6 submissions from UK (Scotland), Sweden, Ireland, France, Poland and Spain have been approved. The French exemption was revoked as it was considered that the application no longer constituted an administrative burden (EC regulation 57/2011).

In the first evaluations, conducted by written procedure (STECF 2009), STECF was requested to evaluate a number of exemption cases, based on the following Terms of Reference:

a) *Does the submission provide appropriate data on cod catches and discards to allow STECF to assess the percentage of cod catches made by each group of vessels concerned?*

b) *Whether the percentage of cod catches (including those subsequently discarded) as assessed by STECF, is less than or equal to 1.5 % of the total catches (including those subsequently discarded) of each group of vessels concerned.*

*STECF is requested to pay particular attention to the following elements:*

1. *Do the data and information submitted permit STECF to identify a discrete group of vessels to which the provisions of Article 11(2) of Council Regulation 1342/2008 of 18 December 2008 apply?*

2. *Does the group or groups of vessels identified exhibit similar types of fishing activity during specific management periods within specific cod conservation area(s)?*

3. *Taking into account time period, spatial coverage and fishing pattern, are the observed catches of cod (landings and discards) considered representative of the catches of cod for the groups of vessels identified in the Member States' submission?*

4. *Does the submission contain appropriate catch data for the groups of vessels identified to permit STECF to evaluate whether the catch of cod is less than or equal to 1.5% of the total catch for those vessels?*

5. *If STECF concludes that the data and information are insufficient to assess whether the catch of cod is less than or equal to 1.5% of the total catch for the vessel groups identified in the submission, STECF is requested to specify the data that are required in order to permit such an assessment.*

At the start of the evaluation process undertaken by STECF, the Information presented by the individual member states varied considerably, and this remained an issue for subsequent applications. It should be noted that the implementation regulation that lays down the detailed rules for the application of 1342/2009 only came into effect in 2010 (EC regulation 237/2010). This legislative vacuum resulted in STECF having to develop evaluation criteria and data requirements to answer the specific details (1-5) highlighted above. This led to an adaptive process over several plenary meetings whereby the data and criteria STECF considered necessary to undertake individual evaluations following the specific detail identified above. For example, in the first set of five applications, only Sweden was able to satisfy the criteria. In some cases only landings information was presented so it was not possible to assess whether catches were below the 1.5% threshold. In cases where observer data was presented, there was insufficient information to link the observed trips to the vessels seeking exemption or a lack of spatial data precluded any analysis to ascertain whether the catch data was representative of the fleet seeking exemption.

In its first and all subsequent responses, STECF (2009; 2010; 2011) identified the data deficiencies associated with each of the ToRs for each specific case. STECF also made some general comments regarding the provisions of article 11, in particular its concern that vessels could achieve exemption due to the severely depleted nature of some of the cod stocks e.g. Kattegat, Irish Sea and West of Scotland stocks, and that exempting vessels in such circumstances would be contrary to management attempts to rebuild the stocks in these areas. STECF (2009) noted the following:

*STECF considers that catches of cod <1.5% at a fleet or individual vessel level can be achieved through three possible mechanisms:*

(i) *Technical decoupling through the application of modifications to the fishing gear that inhibits or reduces cod catches;*

(ii) *Spatial and/or seasonal decoupling, where the fishing activity is conducted in areas, at depths, and/or in seasons that are historically not associated with cod distribution and catches; and;*

(iii) *Decoupling through cod stock depletion, where historically, cod catches in the area where the fleet/metier operates are likely to have exceeded 1.5% if the cod biomass was at a higher level.*

*These points may be applied in a hierarchical way for the purpose of evaluating whether proposals for exemption are likely to achieve consistent and long lasting cod catches below 1.5%. Technical solutions offering lasting avoidance of cod would rank highest.*

*STECF further notes that while fleets may technically meet the provisions of Article 11, if this is achieved principally through point (iii) above this may inhibit cod recovery and could result in an increase in cod catches from current levels due to the removal of effort capping as defined under previous cod recovery plans/effort regime.*

*Unless spatial or technical reasons for maintaining catch levels at or below 1.5% are demonstrated and/or proposed, and that evidence presented that demonstrates points (i) and (ii) are the primary reason why cod catches are below the threshold levels, caution should be applied when evaluating submissions that are based solely on recent catch and/or landings data. Applying the precautionary principal, in the absence of technical or spatial/temporal supporting data, it should be assumed that, given the low biomass levels of all cod stocks, that decoupling has been achieved largely as a consequence of stock depletion. Assuming that cod catches will increase in response to increases in cod stock biomass, STECF notes that vessels may be unable to meet the criteria for exemption from the effort regime provided for by Article 11. Under these circumstances, it would be necessary for vessels to lose their exemption and that adequate monitoring is required to determine if the vessel group remains exempt or not.*

*STECF further notes that it would require additional data to assess the likely impact that article 11 may have on cod catches if a member state expects that the application of the article would result in a transfer of effort into metiers availing of article 11. To assess the potential impact STECF will require an assessment of what the likely increase in effort would be and the cod catches associated with the additional vessels prior to application of article 11.*

By the end of the spring plenary in 2009, 16 separate fisheries had been considered. The process had revealed a wide range of data types and quality and with this in mind, STECF proposed the development of a hierarchy as follows:

- Lowest level – list of landings data associated with a list of vessels
- Low-Medium – list of landings data associated with a list of vessels plus representative observer data from discard sampling programme
- Medium-High - list of landings data associated with a list of vessels plus representative observer data from discard sampling programme plus detailed spatial analysis
- High - list of landings data associated with a list of vessels plus representative observer data from discard sampling programme plus analysis that shows technical separation

An important consideration is that while fleets may technically meet the provisions of article 11, if this is achieved principally through depletion decoupling, then this could result in an increase in cod catches from current levels due to the removal of effort capping as defined under previous cod recovery plans/effort regime and this may inhibit cod recovery.

Unless spatial or technical reasons for maintaining catch levels at or below 1.5% are demonstrated and/or proposed, and evidence is presented that demonstrates points (i) and (ii) are the primary reason why cod catches are below the threshold levels, caution should be applied when evaluating submissions that are based solely on recent catch and/or landings data. In respect of the distinction between points ii) and iii) there is clearly a need for longer term information on stock distribution and metier behaviour to ascertain the basis of current low cod catches. Applying the precautionary principal, in the absence of technical or spatial/temporal supporting data, it should be assumed that, given the low biomass levels of all cod stocks, decoupling has been achieved largely as a consequence of stock depletion. STECF notes that vessels may no longer be able to avail of the provisions under Article 11 if cod catches increase in response to increases in biomass. Under these circumstances, increasingly exacting monitoring would be required to ensure that in the event of an increase in cod abundance, it was possible to detect when the threshold had been exceeded, thus requiring removal of the exemption.

STECF further noted that it would require additional data to assess the likely impact that article 11 may have on cod catches if a member state expects that the application of the article would result in a transfer of effort into metiers taking advantage of article 11. It is unclear, going forward, what arrangements there will be for vessels adopting measures which reduce cod catches (e.g. effective technical/gear solutions) and wishing to become exempted. To assess the potential impact of such developments, STECF will require an assessment of what the likely increase in effort would be and the cod catches associated with the additional vessels after application of article 11.

The establishment of exempted groups may lead to a number of unintended consequences. Obvious amongst these is disputes and challenge arising from groups failing to acquire exemption. STECF considers that any granting of an exemption should therefore be based on a robust case and supporting data. Most of the applications use similar basic data types. These are not always analysed to the same extent however, so that following a refusal it is likely that repeat submissions with more detailed analysis can be expected. In the case of exemptions based on spatial decoupling, consideration will need to be given to the potential for increases in effort in localised areas on species other than cod. This attains additional importance if, over the course of time, the exemption attracts additional vessels.

STECF also noted that the provisions of Article 11(2) create a situation where it is difficult to predict what the likely changes in mortality on cod will be in the event of exemptions being granted. Firstly, in common with other bycatch Regulations, the amounts of cod removed in compliance depend not only on the cod catch but also on the total catch of all species. High catches of other species in a mixed fishery will lead to larger amounts of cod being removed even if the % bycatch limit is not exceeded. Secondly, the overall amount of cod removed depends on the aggregate effort of the vessels in the exempted metier. For any group with a current bycatch of less than 1.5% cod but restricted in available effort, the removal of the effort restriction could lead to more cod being caught. Furthermore, if the granting of effort exemptions leads to more vessels moving to the exempted metier, there may be potential for further increases in cod catch. This depends on the nature of the metier that is being left in order to join the exempted group – vessels leaving a metier characterised by high cod bycatch will almost certainly catch fewer cod under the exemption, but the balance is not so clear for vessels leaving metiers which already have low to medium cod catches. In order to better predict the effects of granting exemptions, more detailed evaluations would be required than has hitherto been possible. The application of catch percentages as a metric could also be considered a perverse incentive in that it discourages fishermen to reduce discards of other species as in doing so, achieving 1.5% or less cod will be more difficult, even is the cod catch remains the same.

Further evaluations were considered by STECF (2009). A number of additional points for consideration in evaluating MS submissions were raised by STECF. These have in some cases led to further requests for additional material to be supplied by member states before a thorough evaluation can be made. STECF (2009) called for the development of a structured approach involving stable criteria is considered essential for the ongoing evaluation of Member State submissions, which will increase with the implementation of Article 13 of the Council Regulation. During the summer plenary in 2009, STECF was asked by Commission services to *"Provide recommendations for the detailed rules concerning format and content for the annual reports which Member States have to provide in accordance with Article 11(3) of Regulation 1342/2008. If due to the different criteria applied for exclusion Member States will be requested to provide different data in the annual report, the STECF is asked to provide these specific requirements for each of the criteria separately."* In it's response STECF (2009) made the following recommendations for appropriate data:

- A list of the vessels belonging to the group, together with their Community Fishing Register (CFR) number and information on the following technical characteristics: gears deployed, mesh sizes, vessel size, engine power.
- Landings by weight of cod and all other fish, crustaceans and molluscs by all vessels identified as belonging to the group of vessels together with the fishing effort (kW days) deployed to obtain those landings.
- Landings and effort data should be provided by vessel, month and statistical rectangle for the most recent year.
- Representative samples of the catches (landings and discards) of cod from vessels identified as belonging to the group of vessels together with the fishing effort (kW days) deployed to obtain those catches. Sampling precision should at least correspond to the levels in the DCF.
- Spatial and temporal coverage: sampling levels (such as sampled effort versus total effort) should be given for onboard observer schemes for the exempted group(s) of vessels.
- Those groups of vessels exempted under spatial decoupling criteria due to fishing activity taking place in depths greater than those inhabited by cod should provide data to show that all fishing activity has taken place at depths below 300m.

By the end of the summer plenary in 2009, 31 separate fleets had been evaluated by STECF and the commission. STECF (2009) notes that "*The Commission clarified that STECF is requested to judge whether, based on the scientific evidence presented, it can be ascertained that real decoupling between the fishing activity and the impact on cod stocks exists*". However, during the Winter Plenary (2009), STECF was asked again to reassess the submissions presented during the previous plenary meeting. The background information from the commission noted the following:

*The Commission's approach to vessel exclusions under the cod plan (Article 11(2) cod plan) has taken into account the STECF's concept of technical or biological decoupling, but would in addi-*

*tion favour vessel exclusions based on vessel group characteristics that result in current catch rates of cod below 1,5% in the vessel group (on average), provided that*

*a) the effort reduction coming along with such an exclusion would be permanent,*

*b) the vessel activity would be automatically counted against the reduced effort ceilings when either a vessel no longer meets the group characteristics or the group catches exceed more than 1,5% cod (averaged over the year), and*

*c) the Member State has put in place a monitoring system that will provide representative catch data enabling the Commission to assess whether the fulfilment of the exclusion criterion at the group level continues to be met.*

The terms of reference therefore simply asked whether the cod catches were in fact below 1.5% with no reference to detailed elements requested previously (see page ?). STECF (2009) reiterated its previous concerns relating to the problems of being unable to disentangle the likelihood of spatial from depletion decoupling from any given case and noted "*STECF do not consider the third criteria as a condition for effort exemptions. Providing effort exceptions to groups of vessels that meet the third criterion has the potential to negate any attempts to reduce cod mortality and could inhibit stock rebuilding*." The inclusion of point (a) above was to provide a strong incentive to ensure that the group of vessels seeking exemption were associated with areas outside the historic distribution of cod as if stocks recovered and cod catches went above 1.5% in future then effort would have to be taken from a reduced effort allocation. However, following the December council in 2009, point (a) above was not introduced.

Summary points

STECF recognised the potential weakness in the article in so much that it made it possible for vessels to be exempted from the effort regime in areas where cod stocks are severely depleted e.g. cod catches are below 1.5% because of depletion decoupling. In such situations, this could be counter to the objectives of the plan.

The evaluation process evolved over time. In the initial stages, STECF added additional data requests to Member States in order to determine whether cod catches were below 1.5% due to spatial, technical or depletion decoupling. This process was potentially confusing for member states and resulted in variability in the data submissions.

The use of a percentage cod limit in the regulation in article 11 (and 13) provides incentives to maintain higher catch volumes and discourages the use of more selective gears aimed at reducing discards of other species as for a given catch of cod, reducing unwanted catches will increase the percentage of cod in the catch.

To ensure real decoupling between the fishing activity deployed by a group of vessels and the impact on cod stocks, the evidence should indicate either

i that the fishing activity is deployed outside the biological distribution area of cod, or

ii that the fishing gear used within the cod distribution area has been designed to clearly avoid cod catches.

<table>
<tr><th>Date</th><th>Member State</th><th>Metier</th><th>Rationale</th><th>Data Submitted</th><th>Outcome</th></tr>
<tr><td>March 2009 (OWP)</td><td>UK</td><td>TR1 (VIa, VIIa, IVa)<br>TR2 (VIa, VIIa, IVa)</td><td>• Cod catches below 1.5%<br>• No technical decoupling<br>• No spatial decoupling</td><td>Landings: Y<br>Discards: N<br>Effort: Y<br>Spatial Activity: N</td><td>Unsuccessful<br>• Unable to link observed vessels with applicant group<br>• Unable to commonality in fishing activity<br>• Unable to quantify catch, only landings<br>• Request further data for future evaluation</td></tr>
<tr><td></td><td>IRE</td><td>TR1 (VIa, VIIa)<br>TR2 (VIa, VIIa)</td><td>• Cod catches below 1.5%<br>• No technical decoupling<br>• No spatial decoupling</td><td>Landings: Y<br>Discards: Y<br>Effort: Y<br>Spatial Activity: N</td><td>Unsuccessful<br>• Unable to link observed vessels with applicant group<br>• Unable to commonality in fishing activity<br>• Request further data for future evaluation</td></tr>
<tr><td></td><td>SP</td><td></td><td>• Cod catches below 1.5%<br>• No technical decoupling<br>• No spatial decoupling</td><td>Landings: Y<br>Discards: Y<br>Effort: Y<br>Spatial Activity: N</td><td>Unsuccessful<br>• Unable to link observed vessels with applicant group<br>• Unable to commonality in fishing activity<br>• Request further data for future evaluation</td></tr>
<tr><td></td><td>SWE</td><td>TR2 (IIIa)</td><td>• Cod catches below 1.5%<br>• Technical decoupling through sorting grid</td><td>Landings: Y<br>Discards: Y<br>Effort: Y<br>Spatial Activity: N</td><td></td></tr>
</table>

# The North Sea Regional Advisory Council

NSRAC

## Position Paper on the Review of the EU Long-term Management Plan for Cod

June 17th 2011

# 1. Introduction

1.1 The ICES/STECF Joint Scoping Meeting in Copenhagen in February/March 2011 set out terms for the review of a number of long-term management plans, including the EU Long–term Management Plan for Cod. (EC 1342/2008). Evaluation of the cod plan would be backward looking, in that it would examine how the plan had performed to date in achieving its objectives. The final report could be expected to be influential in shaping future cod recovery measures in the areas currently within the recovery zone (North Sea, Kattegat, Eastern Channel, West of Scotland and Irish Sea). The NSRAC and other stake-holders:

Contributed to the discussions at the Copenhagen meeting

Were invited to prepare and submit a report on the performance of the Cod Management Plan that would be included as an annex to the ICES/STECF report

Were invited to nominate a topic and (STECF funded) expert to investigate any aspect of the Cod Plan of particular interest to stakeholders.

This Position Paper summarises the considered views of the North Sea Regional Advisory Council on the Cod Management Plan.

1.2 Broadly speaking, the Cod Management Plan does not appear to have performed as well as anticipated by its architects. In summary, the Cod Plan has been diverse in its effects but without apparently achieving its objective of achieving a low level of fishing mortality for cod.

Some vessels face serious economic pressures directly as a result of the provisions of the plan.

Others have already been removed from the fleet directly or indirectly as a result of the plan.

Many vessels have redirected their effort to other fisheries, where cod are less likely to be caught, but have found that their abilities to fish for those other species are impaired by the provisions of the plan.

Some vessels have not been able to fish their quota and as a consequence have lost their historical fishing rights because of the plan.

Some vessels would like to improve the selectivity of their fishing gears for species like plaice, but are prevented from doing so by the plan.

Other vessels are still largely dependent on catching cod, haddock and other demersal species and have adopted stringent and costly procedures to validate their catches and demonstrate conformity with the plan.

The Cod Recovery Plan, with both TAC provisions and days at sea restrictions, has reduced fishing opportunities for many fishers, and has also increased their costs but without achieving the overall reduction in fishing mortality considered necessary for rebuilding the cod stocks.

In some cases the plan has promoted discarding. The NSRAC shares the ambition of the Commissioner to curb large scale discards that waste the resource and disfigure the reputation of the fishing industry and the Common Fisheries Policy. However, heavy-handed top-down controls, like the discard ban that has now been proposed, may produce arresting headlines but rarely translate into positive results at sea. Substantial progress has been made by fishers in many countries in reducing discards through initiatives of their own. We have drawn the Commission's attention to these developments on several occasions and have sought support for taking them forward. That support has not so far been received. We have also drawn attention to discarding that arises from the regulations themselves, including catch composition rules and inappropriate minimum landing sizes. We are hoping that reforms to the CFP will sweep away these perverse effects.

1.3 The varied impact of the Cod Management Plan on different Member States and fleet segments is seen at its most intense in relation to the plan's provisions on effort control. In some Member States, and in some fleet segments, the impact of effort reductions has been minimal. In others, the impact in terms of fewer days at sea has been severe. The division between fleets and the lack of flexibility of the effort regime has been a major constraint upon those fishers seeking varied fishing opportunities. Moreover, the most severe restrictions have not necessarily been on those vessels contributing most to cod mortality. Some countries have found it difficult to gain exemptions from the plan under article 11 for vessels that do not catch cod. Some have adopted cod avoidance measures but have found it difficult to obtain additional days at sea under the provisions of Article 13. The NSRAC has attempted to illustrate these differences in impact through the preparation of a series of case studies of the impact of the plan on different vessels. The paper collating these case studies will be attached as an annexe to this Position Paper. The information is intended to complement information on the economic and social impacts of the plan being provided by Member States, and to inform the analysis of impact being carried out by the ICES/STECF WG.

1.4 The NSRAC will present its comments on the Cod Recovery Plan under five headings:

1. Design of the plan
2. Implementation of the plan
3. TAC setting and discards
4. Cod avoidance.
5. Fishers' responses to the plan

## 2. Design of the plan

2.1 The basis of the Commission's original Cod Recovery Plan (2003-2007) was the view that restrictive TACs had failed to prevent an increase in fishing mortality and halt the decline in cod stocks. Blame for this failure was mainly levelled at high levels of unreported landings and discards. From 2003 onwards, TAC and quota limitations were complemented by effort control in the form of days at sea limitations applied to various gear categories in a cod recovery zone. However, the Commission quickly concluded that this approach was too complex. It had generated pressure for derogations that had undermined the purpose of the plan to the extent that it was questionable whether the measures had been sufficient to bring about cod recovery. The plan had failed.

2.2 New legislation establishing a long-term plan for cod stocks in the form of a new Cod Management Plan (EC 1342/2008) was therefore adopted in November 2008. It covered four cod stocks: cod in the North Sea, Skagerrak and Eastern Channel, cod in the Kattegat, cod to the west of Scotland, and cod in the Irish Sea. The new plan was intended to set TACs and effort limits according to predefined rules in response to the latest scientific advice.

2.3 Despite its name, the second phase of the Cod Management Plan was not designed as a coherent plan. There had been inadequate consultation with ICES scientists and stakeholders before the plan was introduced. Specifically there had been no formal impact assessment. This lack of planning led to a number of unforeseen consequences. Effort reductions were bolted on to a system of restrictive TACs without anticipating what the effects might be. The second plan has been less successful than hoped; cod biomass has increased, but fishing mortality upon cod has not fallen to the extent that was planned.

2.4 The lack of attention by the Commission to stakeholders' advice on cod recovery was especially disappointing to the NSRAC. The joint NSRAC/NWWRAC Symposium on Cod Recovery had raised important issues, and had pointed to the pitfalls of introducing unproven measures. It had emphasised the need for incentives to achieve cod avoidance. However, the first Plan was based on setting a target biomass – despite advice from the NSRAC that this was inappropriate. The second phase of the plan had adopted a target fishing mortality – as the NSRAC had originally suggested - but effort controls were then added on.

2.5 Baselines for member states allocations of effort (Kw days) were related to a recent reference period irrespective of whether Member States had undertaken capacity reduction through decommissioning schemes or other means, and irrespective of changes in fishing strategy and quota evolution between geographic areas (mainly between the North Sea and West of Scotland). This created a lottery effect from the outset, which has meant that effort control has been experienced very differently in those member states who happened to undertake decommissioning and other measures within the reference period compared to those who had reduced their effort levels earlier. There was also an attempt to apply the plan over an unrealistic timeframe; over which period recovery to the interim target levels were unlikely.

In particular, TACs were set by the EU and Norway at the lower end of the ICES catch options leading to high levels of discards that undermined any progress made in reducing fishing mortality. Assumptions were made on what effort controls could achieve in terms of reducing fishing mortality, notably a close correlation between fishing effort and fishing mortality was assumed. Those assumptions have proved to be wrong.

2.6 The design of the effort regime has become one of the main issues in the cod recovery plan. It has been designed in order to cover almost all fishing gears (and all demersal fisheries), regardless of the protection required for cod. This means that the plan is not related just to cod, as is intended. The plan has a wide impact on other fishing activities. It is also difficult for fishers to accept that this highly restrictive plan applies only to European vessels. The plan does not apply to Norway, whose fishing vessels also contribute to cod mortality. Furthermore, the definition of the effort groups at a European level leads to the application of effort reduction to a wide range of fishing gears that do not contribute at all to cod mortality. Different levels of implementation of these measures compound the lack of coherence of the effort regime. Finally, the rigidity of the system, the division of the fleet into inflexible segments, and the inherent lack of flexibility limits the capacity of the fleet to change its behaviour (in terms of improving selectivity, transfer to different target species etc.) in order to avoid cod.

2.7 Taken as a whole, those recovery measures that have contributed most to cod recovery have been the strengthened landing controls and provisions for capacity reduction. The measures that have been least successful have been effort control, ultra-restrictive TACs and technical measures, (the latter according to STECF having to a large extent been undermined by the design of the effort regime). The jury is still out on incentivised cod avoidance, partly because of difficulties in assessing its contribution but also partly because of rigidities in the provisions of the Cod Management Plan that have obstructed the full implementation of this approach.

## 3. Implementation of the plan

3.1 Under the original Cod Recovery Plan, harvest control rules required that the TAC each year be fixed at a level that would result in a 30% increase in spawning biomass (SSB), until the precautionary level (BPA) was achieved. That was the level of biomass that scientists consider to be a safe level to avoid stock depletion. However, the resulting TAC was constrained to be within 15% of the previous year's TAC, provided that the stock biomass was above the level that gave a high risk of stock collapse ($B_{LIM}$). If the stock fell below $B_{LIM}$, more stringent TACs would be fixed. An additional and important component of the cod recovery plan required that the effort of fishing vessels fishing for cod should be adjusted in line with the required changes in fishing mortality.

3.2 During the first phase of the plan (2003-2008), reductions in fishing effort were primarily focused on the part of the fleet that caught most cod; defined as that part of the fleet using mesh size over 100mm. As an unforeseen consequence there was a massive transfer of effort from gears traditionally targeting cod (demersal trawls >100 mm mesh size) to smaller mesh trawls (using mesh sizes between 70/99mm).

There was a perverse incentive for fishers to move away from gears that traditionally targeted cod, and which were to be subject to the biggest reductions in effort, towards smaller mesh gears where cod was taken as a by-catch. Because of this transfer, the resultant reduction in fishing mortality was insignificant.

3.3 The new cod recovery plan, put forward in April 2008, placed more emphasis on effort limitation. A simplification of the fishing effort management system was proposed, giving Member States more responsibility for allocating effort, together with a more flexible approach in adapting the rate of reduction in fishing mortality to different stages of recovery. Member States were allocated a kilowatt days 'pot' for each gear category in each sea area but, significantly, a Member State could 'buy back' days at sea for its fleets through various measures. Exemption from effort controls was possible for vessels that did not catch cod. The new arrangements came into force early in 2009.

3.4 In terms of implementation of the plan, there have been different approaches by different Member States. Contrary to claims by the Commission, the plan has not been easy to implement and it has not provided a simple regime for reducing fishing mortality. The plan has shifted responsibility from the Commission to Member States, and has placed a very heavy burden on administrators and the fishing industry. Complex issues have arisen and have led to confusion. Dividing up effort between different vessels within the fleet has proved problematical. The development of a market for days has added complications. It has proved extraordinarily difficult to gain exemptions from the plan under Article 11 for vessels that do not catch cod. In particular, there is a lack of transparency over the criteria used to deliver exemption and over the data to be collected and any "guarantees" required to achieve exemption. A discrepancy in the delivery of exemption to part of a fleet in the same fishery (between Member States or with third countries that do not operate an effort regime) has created disparities in opportunities to market some species, including saithe, and has resulted in unfair competition. Moreover, it has proved difficult to award additional days at sea under Article 13 to those engaging in cod avoidance. Management has turned into a confusing numbers game governed by arcane and incomprehensible rules that have little or nothing to do with constraining fishing mortality.

3.5 The spawning stock biomass of North Sea cod is still below $B_{LIM}$ but the stock is increasing, demonstrating that cod recovery is taking place. Fishing mortality lies between $F_{LIM}$ and $F_{PA}$ and there has been a downward trend in recent years. However, although the landings target for an F of 0.4 has been met, there has been considerable discarding on top of that. For every cod landed an additional cod has been discarded. Poor recruitment of cod has persisted since 2005. Recovery will be maintained if $F_{0.4}$ can be met, but this has not been the case so far. Year on year reductions in fishing effort have failed to maintain the initial downward trend in fishing mortality on North Sea cod.

3.6 With low spawning stock biomass and poor recruitment the NSRAC recognises that it is necessary to adopt a precautionary approach. The Cod Recovery Plan is designed to deal with a maintained level of low recruitment. The plan's aim is to conserve young fish and take a bigger yield from the older fish and it is based on reaching the target fishing mortality of 0.4. The NSRAC accepts that $F_{0.4}$ is a sensible target, and is concerned that it is not being met because of discarding.

3.7 The NSRAC does not believe that the required reduction in F can be met by further reducing effort because of flaws in the design of the current system. Nor is reducing the TAC for cod the way ahead, as this will increase discards still further.

## 4. TAC setting and discards

4.1 The Cod Recovery Plan has created discards through the way it has been designed and implemented. The link between the plan, TAC setting, and the Technical Conservation Measures Regulation (which imposes catch composition rules) has created regulatory discarding. To meet the regulations, some fishers are forced to discard.

4.2 A particular problem at the moment is that North Sea quotas are not matched to fishing opportunities. The TAC has been set too low for the available stocks. With effort restrictions in place and as commercial operators under economic pressure fishers go out to catch what they can with the lowest achievable costs. Some sectors of the fleet wish to reduce the numbers of small cod they catch by increasing their mesh size. However, an increase is not possible because the Cod Recovery Plan uses mesh size as a means of defining different fleet sectors. Smaller mesh vessels cannot increase their mesh size to promote cod avoidance.

4.3 Unreported landings, formerly a problem in the North Sea, may now have been marginalised but there is still a major problem with the discarding of cod. Total removals of cod have not declined in the way the Cod Recovery Plan had intended. There is a hole in the plan; caused by discards. A vicious circle has been set up where effort has been cut and quotas increased but not sufficiently to reflect the abundance of cod on the fishing grounds. Cod are being caught which cannot be landed and this has led to an increase in discards leading in turn to further effort cuts, creating economic difficulties for vessels. The plan lacks an economic dimension. In many cases vessels have adequate quota for other species, but cannot fully take this quota and maintain their income because of the days at sea restrictions imposed under the cod recovery plan. Very diverse fleets, with considerable earning power from other species, are being prevented from operating effectively. Fishers now see all avenues to making a profit being closed and this has adverse implications for the fisheries management system as a whole.

4.4 Fishers and fishery managers originally welcomed the provisions for cod avoidance and discard reduction offered by plan. However, although some of these provisions have been well utilised, others have not. Article 13 ostensibly provides a mechanism for increasing effort allocations in return for conservation measures that reduce discarding and reduce fishing mortality. In practice, these opportunities have not been taken up; perhaps for two reasons:

- The text of the article is obscure and difficult to comprehend and the process of exchange is protracted. It takes a long time for STECF to evaluate the measures being taken
- The standard of proof required is set too high

Article 11 allows for vessels to achieve exemptions from the plan where cod catches make up less than 1.5% of the total catch of the group of vessels concerned. In practice it has proved impossible to obtain exemptions for a number of fleets that are known to catch few cod because of problems in providing sufficient data.

4.5 Greater focus must now be placed on reducing discards. The current plan is flawed in this respect. Effort control was supposed to limit the total removals of cod but has failed to do so. Effort has never been in balance with TACs and the assumed linear relationship between reductions in effort and reduction in fishing mortality does not seem to exist. Initial effort reductions, along with other accompanying measures, may have reduced fishing mortality but that is no longer the case. The simultaneous operation of both an input (days at sea) and an output (TAC) regime has created problems. Discarding of juvenile cod has now been supplemented by economic or regulatory discarding of quality fish with a market value.

4.6 Effort control is now a complex and elaborate encumbrance that contributes little or nothing to further reductions in fishing mortality. Effort levels are linked to one species only – the cod. Yet fleets depend on a range of other species for their income. Many fishers are now opposed to the continuation of a regime based on effort restrictions.

4.7 A solution now has to be found to unlocking two major obstacles:

- The automatic year-on-year reductions in permitted effort that increases the costs of fishing without delivering a reduction in fishing mortality
- The barriers that have prevented the flexibilities present in the plan that would allow wider cod avoidance from being implemented.

4.8 There is strong support within the NSRAC for a "land more and discard less" policy, and for fishers being provided with the incentives to enable them to achieve that aim. The NSRAC also believes that it is important to control removals rather than landings. Landing the quantities of fish now being discarded would make many fisheries more viable. The plan must be changed to encourage the landing of valuable fish. We are advocating a fishery- by-fishery, incentive-driven, results-based approach as part of a more participative system of management under the CFP.

## 5. Cod avoidance

5.1 Responsibility for reducing F essentially lies with the fishing vessels and their operators. This could be achieved by:

- Providing vessels with incentives to avoid catching excessive quantities of cod.
- Insisting that all the marketable sized cod that are caught should be landed.
- Obtaining accurate estimates of total removals, which would strengthen the stock assessments.
- Taking measures to avoid the capture of juvenile and unwanted cod.

- Providing a more straightforward means to achieve exemption from the effort regime for those vessels able to demonstrate low catches of cod would encourage active cod avoidance and would reduce the constraints that are currently imposed on fisheries that do not catch many cod.

As part of the process of instilling confidence in cod avoidance measures taken by fishers it would be necessary to prove that cod avoidance works – the Commission has always been sceptical of fishers' measures.

5.2 The NSRAC has compiled a list of examples of initiatives taken by fishers across Member States to reduce discarding and promote cod avoidance, and has produced a series of comments on the causes of discards and the ways in which discarding might be avoided.

5.3 Our overall aim is to reduce F to the target level. There would then no longer be any reason to adopt measures over and above a legally observed TAC. Indeed, further effort restrictions could be taken off the agenda now if fishers were made responsible for recording accurately all cod removals. The full documentation of catches could also be used to gain exemption from the effort regime, as it provides the necessary guarantees. There would be no reason for reducing days at sea still further. Clearly there must be confidence that fishing mortality has been reduced. That can perhaps best be achieved by validating total removals. ICES is already geared up to allocate fishing mortality to different fleet sectors.

5.4 Pilot projects have already allowed us to assess the ability of catch-quota systems, real time closures and other measures to reduce discards, reduce stock mortality, and encourage fishermen to fish more selectively.

5.5 There will need to be discussions with Norway, which shares the North Sea cod stock, over any move towards recording total removals of cod. Although there is a nominal discard ban imposed on Norwegian vessels it is currently not possible to verify that their landings conform exactly to the catches. There is a margin of error. This issue might be addressed at the EU/Norway negotiations in relation to the review of the cod management plan due in 2011.

5.6 The NSRAC accepts that there must be a robust system for confirming that total removals of cod are accurately recorded. There are many options for achieving such surety, including:

- Remote electronic monitoring systems
- Full observer programmes
- Partial observer programmes with catch profiling
- Verifiable vessel management plans

5.7 Provision for such changes could be included in an additional Article within the cod recovery plan encouraging vessels to move in the right direction. It would be for individual vessels to decide whether to take on the additional task of catch accountability in return for relief from the effort regime. Such changes, if implemented, would reflect some of the aspirations for reform of the CFP. It would be a move towards results-based management. It would implement an adaptive approach. The changes would represent a move away from a system of prescriptive management to one where industry took responsibility for its actions.

## 6. Fishers' response to the plan

6.1 Fishers within different sectors of the fishing industry, and within different Member States, have responded differently to the provisions of the Cod Recovery Plan. The NSRAC hopes that it has captured some of those differences in the annexe attached to this paper.

6.2 The annexe which is being prepared aims to bring the ICES/STECF WG up to date on what has happened within the different fisheries, and considers what also might also take place in those fisheries if the Cod Recovery Plan is extended into the future in its present form. The response of individual fishing companies has clearly differed. Some have moved into fisheries where the catch of cod is minimal. Others, including those engaged in mixed fisheries, have adopted cod avoidance measures. In some cases the response has been to adopt fishing strategies that impede cod recovery. The Cod Recovery Plan has therefore affected different vessels in different ways. In some cases the impact has been minimal; in other cases fishers have found it difficult to maintain economic viability.

## 7. The way forward

7.1 The NSRAC notes that a review of the cod management plan with Norway is scheduled for 2011 and that the economic impact assessment being carried out by ICES/STECF will be an essential part of that review from a Commission perspective.

7.2 The NSRAC is firmly opposed to any further effort reductions in the North Sea. Such reductions would further discourage fishers from entering into innovative management arrangements and discourage them from behaving in a positive manner. The revised Cod Recovery Plan has failed to reduce fishing mortality in the way expected by the Commission, and its provisions should now be revised.

7.3 The NSRAC is willing to play a key role in advising the Commission on how the plan might be amended to achieve the objective of sustainable fisheries for cod and other species in the North Sea.

POSITION PAPER ON REVIEW OF COD MANAGEMENT PLAN
(COUNCIL REGULATION NO. 1342/2008) June 2011

## 1. BACKGROUND / RATIONALE

The aim of this position paper is to provide advice from the North Western Waters Regional Advisory Council (NWWRAC) in relation to the ongoing evaluation process of the cod management plan for the following areas: West of Scotland (VIa), Irish Sea (VIIa) and Eastern Channel (VIId). The paper seeks to identify the key issues and propose alternative approaches to those elements of the cod recovery plan which have not delivered the desired outcomes.

That paper is put forward as a background document to inform the discussions of the ICES/STECF Expert Group on Long Term Management Plans that will take place in Hamburg (2024 June 2011). The NWWRAC would like to request that ICES/STECF takes the paper into account during its deliberation and that it is included as an Annex to the meeting report.

This document has been adopted by the members of the Executive Committee of the NWWRAC following consultation and completion of a series of deliberations held at a Focus Group (NWWRAC Focus Group on Review of Cod Recovery Plans (BIM Dublin, 30of May 2011): North Western Waters RAC ) and taking account of written submissions and suggestions of the membership of the NWWRAC.

## 2. INTRODUCTION – OPENING REMARKS

• **Scope of study**

The European Commission is currently undertaking a review of the Council Regulation No. 1342/2008 in accordance with article 34 of that regulation and has requested STECF and ICES to carry out a historic evaluation of existing plans, namely North Sea cod, Kattegat cod, Channel cod (as part of the North Sea), West of Scotland cod and Irish Sea cod. For the purposes of this discussion paper, West of Scotland cod, Channel cod, and Irish Sea cod are only considered. The main articles considered in 1342/2008 are articles 2,3,5,6,7,9,11,12,13,17,33, and 34.

• **Decision-making**

In view of the specificities and dynamics of the cod fisheries, a regional approach should be adopted for the management of the cod stocks in a context of mixed fisheries in the north western waters rather than a "one-size-fits-all" area. As a result, a new governance structure must be set in place within a reformed CFP to allow collaborative work between European institutions (i.e. Commission, Council, European Parliament), Member States and stakeholders. A bottom-up approach is required in terms of implementation of cod management measures on a fishery-by-fishery basis. The adaptive nature of the implementing rules and a results-based management would be the foundations for the success of any future cod management plan.

• **Simplification of rules**

The fact that the cod plan is not a stand-alone plan, because of the wide range of the effort regime, results in an overlapping of the following sets of rules: technical measures including catch composition rules; effort regimes; TAC; and long term management plan of related species. This has lead to conflicts and contradictions in implementing the plan successfully and in achieving the objectives set in the plan in terms to reducing cod mortality. The review should take into account this matter and favour a more simplistic and integrated approach while taking into account regional specificities.

• **Maximum Sustainable Yield**

The NWWRAC is of the view that both from a theoretical and a practical perspective, maximum sustainable yield is most usefully understood as a range of values rather than as a particular point value on the fishing mortality scale.

From a fisheries management perspective, a range of values offers the possibility of adapting management measures, and in particular harvest rules, that are adjusted to the realities of mixed fisheries and achieving more realistic MSY targets.

• **Integration of the plan with future scientific advice**

There is a need to set on a mechanism to incorporate the forthcoming benchmark that ICES will undertake for all European cod stocks into the ongoing review process. This will ensure transparency and coordination and help to build a strong and coherent plan.

- **Questions to be addressed**

The North Western Waters RAC participated in the ICES/SECF joint meeting held in Copenhagen on 28th February to 4th March 2011. On the basis of this meeting, which scoped out the main terms of the review of the Cod Management Plan, the RAC understands that a number of important questions will be addressed. In addition are a number of equally important questions that the NWWRAC understands will not be addressed by ICES/STECF. In conjunction with the North Sea RAC the NWWRAC will try to shed light on some of these questions using a separate questionnaire and independent expert funded by STECF.

A preliminary questionnaire of suggested questions might be found in Annex I of the paper.

## 3. GENERAL ISSUES RELEVANT TO ALL THREE AREAS IN NORTH WESTERN WATERS

The evidence suggests that current cod management plan is based on two assumptions. The first is that there is a significant and direct causal correlation between a reduction in fishing effort and a reduction in fishing mortality. The second is that that a reduction in total allowable landings will achieve a reduction in total allowable catch. The evidence suggests that both assumptions are questionable and in the context of the West of Scotland and Irish Sea, unrealistic.

With regard to effort, far from there being a 1:1 relationship between effort and mortality, the evidence suggests that there is in fact a very weak correlation, except close to the point where fishing vessels would face commercial extinction. And with regard to the question as to whether TACs constrain fishing mortality, current ICES advice indicates that, catches of cod on the west coast of Scotland are currently 4/5 times the TAC (and therefore landings), the balance being discards. This would suggest that in mixed fisheries and within the current management regime a simple reduction in TAC to reduce species specific mortality remains a fundamentally flawed approach.

In view of the above, we can affirm that the instruments being used to achieve a reduction in cod mortality are not fit for purpose. The NWWRAC considers that an alternative approach based on effective and validated cod avoidance plans would provide a more realistic means of achieving the desired reduction in F. Certainly, reliance on cod avoidance plans as a central part of a strategy to rebuild cod stocks and ensure that catches of cod remain within catch limits, could hardly achieve less than the current plan has in the Irish Sea and West of Scotland. It will be essential that future cod avoidance plans are well designed and implemented, with adequate safeguards as well as a high degree of participation and industry involvement. A regional seas focus will strengthen the design and implementation of a revised plan.

The NWWRAC would also like to clarify the relationship between fishing and natural mortality. Natural mortality, defined as the mortality caused by anything other than fishing, can take many forms: predation, disease, stress related mortality, old age, etc. Four main factors, independently or in combination, may well be responsible for increased of natural mortality in VIa and VIIa cod stocks; evolutionary changes caused by fishing; changes in ambient temperature; changes in the ecosystem balance caused by fishing; or otherwise and predation.

There is evidence from other cod stocks that natural mortality is higher than 0.2 and indeed that natural mortality has increased over time (Sinclair, 2001)[2]. Recent ICES advice has highlighted that while total mortality has remained very high, it cannot be accurately partitioned into fishing mortality and natural mortality. In reality it is extremely difficult to partition fishing and natural mortality for fish stocks and ultimately only the fishing component of the mortality can be directly controlled.

The assumption of a constant natural mortality of 0.2 seems questionable in relation to the cod fisheries in the West of Scotland and Irish Sea. Whilst it is unlikely that seals "caused" the decline of cod in these regional seas, ICES makes the valid point that there is compelling evidence to suggest that predation by the rising grey seal population is inhibiting recovery, notwithstanding the adoption of various constraints on fishing mortality.

Within an ecosystem approach, a thorough analysis of all ecosystem elements is required and it is crucial that this non-anthropogenic influence is not disregarded.

The NWWRAC notes the various studies that suggest that cod has entered a period of low productivity due to various environmental influences and it is important that these factors as well as seals predation are fully taken into account in the design of a revised cod management plan and in particular the timeframe over which it is reasonable to expect cod to recover.

### 3.1. Objective of the Plan (ART 5)

The objective of the plan is "the sustainable exploitation of the cod stocks on the basis of maximum sustainable yield" to "be attained while maintaining the fishing mortality at 0.4 on cod on appropriate age groups". The NWWRAC is of the view that the management plan is not achieving its objective and is very unlikely to do so in the future particularly for West of Scotland and the Irish Sea cod stocks.

The NWWRAC concurs with ICES that the plan as adopted is "non-precautionary" and the objectives stated there cannot be met under the present conditions and provisions of the plan. For this reason, ICES does not provide advice on the basis of the recovery plan. Therefore, a new intelligent and alternative approach needs to be adopted to make sure the objectives are met.

### 3.2. Minimum and |Precautionary levels(ART 6)

The stock assessment models used for cod in the Irish Sea (VIIa) and West of Scotland (VIa) use Research Vessel survey data to estimate total removals from the stock. These estimates of total removals are typically multiples of reported landings and estimated discards, despite more accurate landings reporting and better discard estimates for cod in recent years. This 'missmatch' has led to concerns among ICES scientists that natural mortality may well be higher that is assumed in the assessment (a fixed instantaneous rate of 0.2 is assumed for each age and year). That in itself has an impact on MSY estimates and the level of response in fishing mortality that one might expect from reducing cod catches and fishing effort within the CLTP. What is of greater concern is that natural mortality may have increased over time

The minimum and precautionary levels set for the West of Scotland and Irish sea (article 6) are not appropriate and are in the view of the NWWRAC unrealistic and fail to recognise the significantly changed environmental circumstances (and its incidence in natural mortality) that now prevail compared to when these targets were originally set in the seventies.

Furthermore there seems to be an inherent contradiction in the plan between the objective which is set in fishing mortality terms and minimum and precautionary levels that are set as biomass targets.

The "Whereas" section of the regulation 1342/2008 states in its paragraph (4): "According to recent scientific submissions, in particular on long-term trends of marine ecosystems, desirable long-term levels of biomass cannot be determined with accuracy. As a consequence, the objective of the long-term plan should be changed from a biomass based target to a fishing mortality-based target…" This contrasts sharply with the statement made on the same page of the plan, under paragraph (9): "The establishment and allocation of catch limits, the fixing of the minimum and precautionary levels of stocks and of the level of mortality rates, as well as the maximum allowable fishing effort for each effort group… are measures of prime importance to the Common Fisheries Policy."

The result of this imprecision is that TAC and Effort setting rules in the plan become rigidly formulaic: the limitations of biomass-based management are acknowledged but it is then immediately used as the foundation of practical management. Given the quality and availability of data, particularly in Areas VIa and VIIa where assessment is weak, the outcome is automatic, severe and detached from the plan objective.

### 3.3. Poor Data Conditions (ART 9)

Article 9 on the procedures to be utilised in poor data conditions has a direct affect on the areas of concern for north western waters as again a 25% reduction is mandatory when the scientific advice is to reduce catches to the lowest possible level.

Whilst precautionary approach should be implemented in the absence of sound scientific data, the NWWRAC considers that the proposed 25% reduction is arbitrary and does not have a scientific basis. It has severe economic consequences for the fleet while not guaranteeing to rebuilding the stock. It will only result in an increase in discards

Furthermore, the present regulation does not take into account that there are several cases of data poor situations and they can only be tackled on a fishery-by-fishery basis. In this respect, the North Western Waters and the North Sea RAC have recently met with ICES and Member States representatives to set up regional task forces to identify and improve data gaps for some priority stocks such as Cod. Initiatives for improving data collection, for example onboard observers, should also be considered.

### 3.4. Fishing Effort Regime and Allocations (ART 11)

The fishing effort regime adopted in the plan is a major cause for concern for the industry and unless it is amended it will ultimately lead to zero fishing effort as the regulation has an automatic 25% reduction year on year built into the regulation when the fishing mortality and biomass targets in Articles 5 and 6 are not met. This is covered in more depth in each of the three cod areas below.

### 3.5. Exemptions and Allocation of extra effort (ARTS 11-13)

Articles 11 and 13 provide for exemptions and the allocation of extra effort. The conditions set down for exemptions and allocation of extra effort is very onerous and applies to groups of vessels and to effort groups.

Hence, the possibility offered by Article 11 to exempt some vessels from the effort regime appears to be difficult to achieve. In particular, there is a lack of transparency over the criteria used to deliver the exemption and over the data to be collected. The lack of any reasonable assurance that efforts to achieve an exemption through various kinds of cod avoidance will be outweighed by the benefits has undermined the positive intentions in the plan. In practice, it has proved to be almost impossible to obtain exemptions, in particular when applying the criteria of the STECF (based on the assumption of a homogeneous and widespread distribution of cod).

It should be possible to design a system that if a vessel does not catch cod it can acquire an exemption in a short-period of time

### 3.6. Effort Groups

The NWWRAC considers that the effort groups, as described in Chapter III (Arts 11-17) and Annex I of the Regulation 1342/2008, are far too wide to be a basis for management measures covering for example mixed demersal *nephrops* and flat fish fisheries

**3.7. Funding (ART 33)**

The funding provided under article 33 relates to the European fisheries fund which expires in 2013. A replacement funding mechanism is required that has both enhanced scope and additional financial support across stakeholders groups

**3.8. Review (ART 34)**

The review process included in article 34 is very weak. The only mandatory requirement is to evaluate the impact of the management measures on cod stocks concerned. There is no requirement to propose relevant measures to amend the regulation only where appropriate.

**4. Cod Recovery Plan: Main Issues Relating to West of Scotland (VIA)**

## 4.1.Geographical Definition(ART 3)

The geographical definition of Article 3 for the West of Scotland is not appropriate and covers areas where cod are not present now or indeed in the past. It should be confined to an area east of the area defined in article 13(d) of Regulation 1342/2008 and within that area specific areas should be excluded that contain very small quantities of cod.

**4.2. Objective(ART 5)**

There has been a huge reduction in fishing effort approximately 70% in area VIa over the last ten years, as it might be seen in the graph below. However there has been very little change in total mortality. This clearly points to fact that total mortality is the problem and not fishing mortality

It is very important to identify properly the components of total mortality and their relative sizes. Assumptions made in the absence of such data will be flawed. Therefore an objective based on fishing mortality only is doomed to failure. The other factors affecting mortality such as predation and any regime shift due to climate change must be taken into account.

**Figure 1. Fishing effort in West of Scotland**

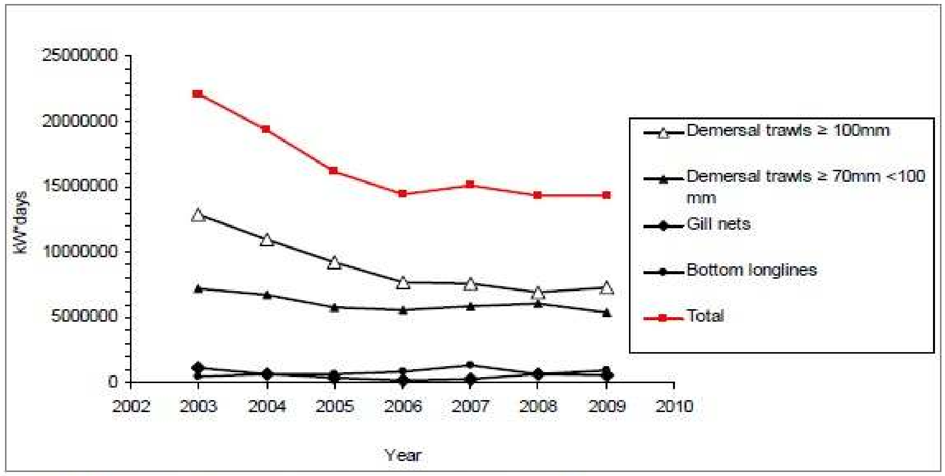


Figure 6. Regulated fishing effort in the West of Scotland.

**Source:** Communication from the Commission concerning a consultation on Fishing Opportunities COM(2011) 298 final Annex II –Fishing Effort regulated under multi-annual plans, as reported by Member States to STECF (information provided by the Joint Research Centre)

**4.3. Minimum and Precautionary Levels (ART 6)**

The minimum and precautionary levels set for area VIa are 14,000 and 22,000 tonnes, respectively. These levels are not attainable particularly as already pointed out above that it seems more than likely that factors other than fishing mortality are affecting the biomass. Trying to attain these bio-mass levels by reductions in fishing mortality only will not work.

As the TAC setting procedure in Article 7.2(a) provides for a mandatory 25% reduction when the bio-mass level is below the minimum spawning biomass, it is only a matter of time before all vessels operating in VIa will have will have little or no effort allocation. A new approach is required that limits and controls total mortality other than natural mortality.

**4.4. Poor Data Conditions (ART 9)**

Article 9 on the procedures to be utilised in poor data conditions has a direct affect on area VIa as again a 25% reduction in both TAC and effort is mandatory when the scientific advice is to reduce catches to the lowest possible level.

The ICES scientific advice for 2011 clearly identifies this poor data condition and states: "Quantities of landings and discards are not included in the model (only weights at age information) because of concerns over unreliability in the historical commercial data. Mortality estimates arising from this assessment -based on survey data -are poorly estimated. Because of uncertainties in the level and trend of natural mortality it is not possible to predict landings estimates from the forecast, only removals associated with both fishing and unaccounted natural mortality."

The NWWRAC believes that the fishing industry is therefore left in the untenable position created by very poor data being used in the prescriptive process of the plan. This results in an inevitable year on year reduction of 25% in both effort and TAC -a very rapid downward spiral which despite the level of economic and social pain will not meet the plan objective. A clear priority exists within the NSRAC-NWWRAC task force initiative to work with ICES to improve the input to decision making

### 4.5. Technical Conservation Measures

Area VIa, unlike the other areas, has a number of unworkable technical measures imposed in part of area VIa East of 200 metres contour. These measures are not included in relegation 1384/2008 instead were initially adopted in the TAC and quotas regulation for 2009.

They were subsequently transferred to Regulation 1288/2009 for a period of eighteen months up until end June 2011. This has now been further extended for eighteen months.

These measures effectively rule out the use of TR1 and TR2 gears as defined in Reg. 1342/2008 in the defined part of area VIa and only allow a by-catch of haddock. This is not only extremely confusing but more importantly has ruled out fisheries that have no affect on cod stocks and has stopped a directed haddock fishery which has been a key fishery for area VIa.

Further, the imposition of catch composition rules aimed at limiting catches of cod, haddock and whiting are resulting simply in increased discarding. STECF has stated (STECF 35Plenary Meeting Report (PLEN-10-03) page 66 ) : "In practice, catch composition as prescribed in current EC regulations relate to the retained catch selected onboard following capture and is not related to the composition of catch selected by the fishing gear. STECF notes that catch composition regulations may not meet the objective of controlling fishing mortality. Catch composition percentages for individual species can easily be met simply by discarding the fish in order to meet the prescribed rates.

The NWWRAC is of the opinion that this will be greatly exacerbated by spike recruitments, one of which (haddock, from 2009) is expected to present itself in the ecosystem now. Anecdotal evidence suggests that it is already evident.

## 5. COD RECOVERY PLAN: MAIN ISSUES RELATING TO IRISH SEA (VIIA)

### 5.1. General Remarks

The cod management plan (EC Reg. 1342/2008), its predecessor, the Cod Recovery Plan and various ad hoc measures put in place to encourage rebuilding of the cod stocks in the Irish Sea, including a seasonal closed area covering the presumed spawning areas, do not appear to have been successful in the Irish Sea. They may not have had any significant positive impact.

The weakness of the stock ICES assessment makes it difficult to make any firm judgment about the current status of the cod stock in the Irish Sea and therefore to make recommendations on the best way forward to rebuild the stocks.

For this reason the NWWRAC considers that rebuilding the assessment, in part from addressing data deficiencies should go hand in hand with redesigning the management plan. Before reviewing some of the individual articles the following is considered as the new approach that should be adopted in the context of the Irish Sea.

Rebuilding the cod stock in the Irish Sea should be achieved by:

Achieving fishing mortality rates consistent with the recovery of cod may be achieved through effective cod avoidance measures obtained with the full involvement and cooperation of the operators of fishing vessels and participation of independent observers. Some examples are:

Selective gear
Spatial and temporal avoidance
Fully documented fisheries
Discard reduction strategies

Appropriate ways of incentivizing effective cod avoidance linked to fully documented catches should be sought, particularly in relation to eliminating cod discards. Two obvious means are:

Additional quota
Exemptions from effort restrictions
A broad fisheries approach rather than basing measures on a stock by stock
ap proach;
A new governance structure based on regional cooperation between member states and high levels of stakeholder involvement;
A realistic time frame for recovery, recognising that whilst we may be in a
period of low productivity for cod it is important to rebuild the stocks that are
present;

### 5.2. Design of the Plan (ART 2)

The design of the plan owes more to administrative convenience than to tailored measures adapted to the contours of the fleets catching cod in the Irish Sea. In particular, the effort groups based on mesh size are crude and blunt in their effect.

#### 5.3. Geographical Coverage (ART 3)

The review provides an opportunity to examine whether it is useful to have a single cod plan with largely common provisions that apply to four different fisheries with different fleet configurations, in widely different ecosystem conditions. In particular, fishing patterns and stock dynamics seem very different in the Irish Seas and West of Scotland compared to the North Sea.

**5.4. Reference Point (ART 6)**

We have already mentioned the absence of a very firm knowledge base for management measures in the Irish Sea as a result of the weakness of the stock assessment. Given this constraint, it is not possible to know if the minimum and precautionary biomass levels prescribed in the Cod Plan have any relevance or are even achievable.

**5.5. TAC Setting (ARTS 6 and 7)**

The TAC mechanism prescribed in the Cod management Plan is flawed because:

Currently it is not possible to determine the spawning biomass in this fishery with any degree of certainty; likewise there are major uncertainties over the levels of fishing mortality;

The automaticity build into the procedures for setting TACs each year do not take into account the time that it takes for a stock to rebound, even when the target mortality has been reached;

The application of the TAC setting procedure to the already low TACs in the Irish Sea has led to the situation where there is no flexibility to trial innovative approaches to fully documented fisheries, discard reduction and cod avoidance that have shown promise in the North Sea;

**5.6.Poor Data Conditions (ART 9)**

In the circumstances of the extremely data poor situation in the Irish Sea the Cod Plan requires an automatic 25% year on year reduction. There is no prospect of this situation changing without intervention despite the requirements of the Data Collection Framework Regulation. ICES and the NWWRAC are currently working on ways of addressing the data deficiency problem in the Irish Sea but in the meantime the automatic TAC reductions continue each year, making it harder to develop innovative and participative ways of addressing the issues. The downward spiral of poor data leading to low TACs, leading in turn to unrecorded discards is simply given extra fuel.

**5.7. Fishing Effort (ART 11)**

The conservation advantages of an effort regime in the Irish Sea are hard to discern. A combination of restrictive TACs and effort control has led to the transfer of fishing activity from the whitefish to the *nephrops* sectors;

Derogations from effort restrictions have been made unduly difficult to achieve;

The timing of member states' decommissioning schemes in relation to the establishment of effort baselines has made the effort regime a lottery; to date most vessels in the Irish Sea have not been constrained by the effort regime;

One can speculate that if effort did become a constraint the Cod Plan would encourage discarding of small cod in order to achieve the discard rates; there is therefore a catch 22, without fully documented catches it is not possible to determine levels of discards but fully documented catches will preclude vessels exemption from the effort regime.

### 5.8. Cod Avoidance / Effort Exemptions (ART 13)

The motivation behind the inclusion of effort exemptions for vessels actively involved in cod avoidance behaviours was a wholly positive one. Regrettably, the provisions have been so hemmed in with conditions and complexity that much less has been achieved than its potential.

If effort control is to be continued (although we can see no conservation reason why and many economic reasons why not), there should be much greater scope for vessels demonstrating effective cod avoidance to secure exemption. The NWWRAC feels that it is this sphere that most progress could be made in rebuilding cod stocks in the Irish Sea but it requires a genuinely participative approach, appropriate incentives and appropriate methods of catch verification. An EU funded pilot project to improve catch data verification, with coverage by observers, could help to implement cod avoidance plans and to benefit from these exemptions

## 6. Cod Recovery Plan: Main Issues relating to the Channel (VIID)

The Eastern Channel is a part of the North Sea-Kattegat Cod stock and as a result the area considered for the effort regime covers the North Sea and the VIId. Nevertheless, this effort regime doesn't cover the fleets from Norway that also contribute to cod mortality in the European Waters. On the other hand, the rules used to fix the TAC for the area VIId results from the discussion in the EU/Norway agreement

### 6.1. Design of the Plan

The main issue for the fleets in the area VIId is the effort regime. The effort regime constrains all the fisheries in the area even if those for which cod is not present in the catches or represents a small proportion of the catches. For the majority of the fleet working in the area VIId cod represents less that 5% of the landings.

The main problem seems to come from:

The definition of the effort groups, based on the mesh size criteria, which includes a wide range of different fisheries/métiers that do not contribute to the same extent to the fishing mortality;

The rule that leads to a systematic reduction of effort (based on the assumption that there is a link between fishing mortality and effort), and the hypothesis of an automatic rebuilding of the stock with a decrease of effort;

The lack of flexibility between the groups of effort.

The different levels of implementation (European or Member State with or without STECF advice) of these measures compound the lack of coherence in the effort regime.

The main consequences of these provisions of the plan have for some fleets is to limit their ability to catch their quotas. Furthermore, the rigidity of the system limits the economically important polyvalence of the fleets (through the use of different type of gear during the year, or in the possibility to increase their mesh size to meet the requirements of other regulations such as technical measures).

### 6.2. Implementation

As noted in the previous paragraph, the cod management plan covers a large part of the gear used in the VIId (and other areas) and is not a stand-alone plan. This results in an overlapping of the following sets of rules (Technical Measures, effort regime,TAC..)

This can lead to conflicts and contradictions and can partly explain the difficulty in implementing the plan successfully and in achieving the objectives set in the plan in terms to reducing cod mortality.

**6.3. The Way Forward**

A solution has to be found to unlocking the year-on-year reductions in effort that have an important economic impact on the fleets without delivering a reduction in fishing mortality. The evaluation process should provide some ideas for introducing some flexibility in the effort regime in order to not jeopardize the viability of the fleets but also to provide serious encouragement to various kinds of cod avoidance. Fishermen are firmly opposed to any further reduction in the VIId.

**References**

Sinclair, A. F. 2001. "Natural mortality of cod (*Gadus morhua*) in the Southern Gulf of St Lawrence" – ICES Journal of Marine Science, 58: 1–10.

# Annex AA Questions that the North Western Waters RAC considers should be included in the Review of the EU Cod management Plan (EC1342/2008)

## 1. Questions that the NWWRAC understands are being addressed by ICES/STECF

Is management plan is achieving its objectives?
Are the targets in the plan are appropriate or not (fishing mortality and biomass)?
Is there is a correlation between effort and mortality that would justify effort limitation as a central instrument in the plan?
Is the science is precise enough inform the exact changes in stock status required under the plan to set year-on-year TAC or effort reductions?
What has the fisheries response to the provisions of the management plan been?
Has the plan led to behavioural changes in the direction of sustainable exploitation or in the opposite direction?
What data sets are available to inform these questions?
Is there evidence of a conflict or contradiction between the provisions of the cod management plan and other conservation regulations, e.g. the technical conservation rules? STECF has already commented that the average mesh size in the North Sea has declined under the perverse consequences of the effort regime.
Is F0.4 an appropriate target?
Is the plan achieving the objectives? In other words, what is working and what is not working?
Are there problems in implementing the exemptions?
Are criteria used by STECF valid to analyse MS exemption requests in accordance with the rules included in the regulation?
Is the effort regime working? Can it ever work? Does the starting point for member states' effort base-line, based as it was on a lottery of when each member states had major decommissioning schemes, mean that there is no possibility of an even application of effort reductions? What does this mean for fishing mortality on cod?
What is the risk involved in relying on effort to bring down fishing mortality?
Is the cod plan designed in a way that hinders it from achieving its objectives?
Is the way that the plan is being implemented problematic? It what ways?
Is it possible to achieve an F of 0.4 for cod at the same time we have a high TAC for haddock?
How has effort affected the fisheries fleet by fleet and member state by member state?
Are there any alternative exploitation indicators that could be used for the Irish Sea and West of Scotland?
Are there reasons to believe that the estimates of natural mortality are correct?
Did member states implement the plan properly?
Has the TAC setting been in line with the plan?
What accounts for the high level of unaccounted removals, including discards of mature fish?
Did member states calculate base lines in the same way?

In mixed fisheries, what are the impacts of the non-cod fisheries?
Has the impact of the effort regime fallen on a small number of vessels; to what extent are these vessels involved in some kind of cod avoidance?
Can we prepare a catalogue of "cod saving" gears?
What are the factors influencing the uptake of cod avoidance options?
Are there examples of successful recovery plans (successful or unsuccessful) in other countries that could inform the report

## 2. Questions that the NWWRAC considers important but which may not be addressed in the current review.

**NOTE: Some of these questions will be addressed in part through the RACs' questionnaire exercise.**

Are the effort categories (e.g. TR1) too wide to be the basis for effective management measures, covering as it does mixed demersal, targeted saithe and flat fish fisheries?
Do the biological and fisheries dynamics in the Irish Sea and West of Scotland vary to the extent that significantly different approaches are required to rebuild depleted cod stocks?
Are different objectives desirable for the West of Scotland and Irish Sea fisheries?
Is under-declaration of engine power a factor?
What has been the effect of the default 25% reduction for stocks where there are data poor situations
F0.4 implies a level of biomass that no one has ever seen before, including the gadoid outburst. This is unknown territory. What are the implications? North Western Waters RAC
Does the geographic scale at which the plan is applied have an effect?
What are the factors influencing the uptake of cod avoidance options?
Does the way that the exemptions within the plan are framed help or hinder innovation in cod avoidance as was intended?
Has the plan incentivized perverse fishing behaviours that prevent the delivery of the plan?
Does the plan provide obstacles to the type of derogations that would deliver a reduction in discards?

# Annex 4 Working Document on Rules-based management and Harvest Control Rules for stocks without analytical assessment.

Clara Ulrich, WKROUNDMP 2011

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## Abstract

A particular issue in the implementation of the LTMP for the cod stocks is the absence of accepted assessment for a number of these. LTMP have been designed around the classical concept of defining a target F and yearly HCR aiming at moving from current F levels towards this target F.

However, this can only be achieved in the case where there is an accepted analytical assessment, which is not the case for three out of the four cod stocks concerned. Furthermore, even in the case of stocks with accepted assessment, uncertainty is often largest for the estimate of the current year (at least for VPA-based assessment), and therefore a HCR rule relying too heavily on the final assessment year may become unstable – as was for example the case in 2010 where the intrinsic noise in the North Sea cod assessment drove the final F estimate above the long-term trend, leading to dramatic issues in the subsequent advice around effort reductions.

In this WD, we describe alternative rules that could be used for stocks without an accepted assessment, and which could form the basis of designing LTMP also for such data-poor situation. As a main example, we describe the 6-level Tier system in place in the Alaska fisheries, and we compare it to the attempts to develop rule-based fishing opportunities in European fisheries through the so-called "Policy Statements" or "Policy Papers" from the EC. We discuss the evolution from these EC Policy Statements until 2010 to the 2011 one, and conclude about the potential for using these for the cod stocks under evaluation.

### The Alaska tier system

This description comes from the analyses performed during the CEVIS project (Wolff and Hauge, 2008[1]).

### Basic principles and concepts

The system in place in Alaska is an innovative Overfishing Level (OFL) *tier system*, a decision rule that is part of the TAC setting process and applies to all groundfish stocks in Alaska managed by the North Pacific Fisheries Management Council. This is a set of Harvest Control Rules for maximum Acceptable Biological Catch (max ABC). It furthermore encompasses a strict bycatch regulation (also following the Tier system also for endangered and non-commercial species), a cap on total catches of all species in defined ecosystem and an early observer programme.

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[1]Wolff, F., and Hauge, K.H., 2008. Fisheries management innovations in Alaska: a case study report. Chapter 1 in Aranda (Ed.), 2008 : Evaluation of innovative approaches to fisheries management outside the European Union: The cases of Alaska (USA), Canada, Iceland and New Zealand. Combined Deliverable D5 and D6, CEVIS Project (No 022686). http://www.ifm.dk/CEVIS/CevisProducts.htm

The TAC is set each year for all stocks. The Tier system is defined in the Management Plan for the BeringSea/Aleoutian Islands (BSAI) and for Gulf of Alaska (GoA), and is based on several concepts: optimum yield (OY), maximum sustainable yield (MSY), overfishing and rebuilding of stocks.

OY is defined as the amount of fish which

- "Will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems."

- "Is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor."

- "In the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery."

MSY is defined as "the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions." In this context, a "MSY control rule" is defined as "a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY."

The total allowable catch (TAC) for each groundfish stock in BSAI and GoA is based on three principles

- The Tier system, which provides a quantity of the maximum allowable biological catch (max ABC) for each groundfish stock,

- The groundfish cap, which sets an upper limit for the total TACs for all stocks in a certain ecosystem,

- OY (optimum yield), which may stay at or reduce the TAC from ABC by economic, social or ecological factors.

Max ABC is a preliminary quantity for ABC, which again is the upper limit for the TAC. Max ABC and overfishing level (OFL) are the result of the Tier system, where the Tier is agreed in advance. It is not possible to recommend an ABC above the maximum level. The TAC can be further reduced by other factors, like when the ABCs for all stocks amount to a higher level than the total Cap, of economic reasons or when the ABC is not expected to be taken because of bycatch problems and the strict bycatch regulations.

The management plans have set constraints for the total catches of groundfish, one cap for GoA and one for BSAI. The underlying idea of the cap is that there is a long-term maximum sustainable yield of groundfish for each ecosystem, and which will vary according to the productivity of the system. The range of MSY was estimated by an early version of EcoSim. The range for BSAI groundfish was estimated at 1.8 to 2.4 million metric tons. For precautionary reasons, the OY was set at 85% of the TAC range or 1.4 – 2.0 million metric tons. The OY for GOA groundfish is set to 116 to 800 thousand metric tons. In accordance with the FMPs the sum of total groundfish catches must always fall at or below the optimum yield.

In practice, the cap for the GoA has not been reached and only the upper limit of the range for the BSAI OY range has been used. The cap of 2 million metric tons for the BSAI was introduced in 1982 and was decided by law in 2005, legislated as an amendment.

### Description of the Tier system

The Tier system is a 6-tier set of harvest control rules that applies to all the Alaskan groundfish stocks. Tier system was progressively established over the period 1976-1994, and its current form has been more or less unchanged since 1998.

The bycatch, endangered and non-commercial species are also assigned to a tier. The amount and quality of data on a particular stock, decides which of the tiers goes with the stock.

ABC and OFL are based on estimates of current stock status (if they can be provided) and on harvest rates corresponding to the MSY concept. The rule contains a strategy for rebuilding stocks to MSY levels when they are estimated below the MSY biomass level.

Tier 1 is assigned to those species with the highest level of data and biological information (a stock-recruitment relationship), while Tier 6 to those with very low data and biological information. Each tier contains a formula or set of formulae defining ABC and OFL. ABC and OFL are based on calculations of MSY, but only Tier 1 follows the theoretical MSY concept. Proxies for MSY are used in Tiers 2 – 4.

Tiers 1 to 3 basically require age structured models, and each of these Tiers consists of a 3-part rule, reflecting the state of the stock. One part applies when the biomass estimate is higher than Bmsy, the other two when it is lower, implying no catch when the stock is below a critical level (defined as 5% of the BMSY level). The intention is thus to keep the biomass level above an MSY level, or, if necessary, to rebuild the stock to this level.

Tiers 4 to 6 are a one-part rule. The requirement for Tier 5 is a minimum of biological information and for Tier 6 that there is a reliable catch history for a certain period. Tier 6 is thus constructed in such a way that if there is no data, it is not possible to develop fisheries on new species.

The management plans list all the targeted species, so for a new fishery to develop, there has to be an amendment, and therefore a minimum of information to enter a tier must be provided.

Stocks can move from one tier to another. Most often it is upwards, but occasionally downwards. A stock may go down a tier if the survey coverage was not sufficient or if there is some decrease in the quality of the data input to the stock assessment. Reasons for going up are improvements in the data quality or stock assessment model. Although the Tier system is constructed to take uncertainty into account by defining a buffer (between OFL and ABC), the buffer does not increase with increasing uncertainty. In practice the harvest rate decreases with increasing tier but not necessarily.

The Tiers are described in the following table ((http://www.afsc.noaa.gov/REFM/docs/2010/BSAIintro.pdf)

**Tier**

1) Information available: *Reliable point estimates of B and $B_{MSY}$ and reliable pdf of $F_{MSY}$.*

1a) Stock status: $B/B_{MSY} > 1$

$F_{OFL} = \mu_A$, *the arithmetic mean of the pdf*

$F_{ABC} \leq \mu_H$, *the harmonic mean of the pdf*

1b) Stock status: $\alpha < B/B_{MSY} \leq 1$

$F_{OFL} = \mu_A \times (B/B_{MSY} - \alpha)/(1 - \alpha)$

$F_{ABC} \leq \mu_H \times (B/B_{MSY} - \alpha)/(1 - \alpha)$

1c) Stock status: $B/B_{MSY} \leq \alpha$

$F_{OFL} = 0$

$F_{ABC} = 0$

2) Information available: *Reliable point estimates of B, $B_{MSY}$, $F_{MSY}$, $F_{35\%}$, and $F_{40\%}$.*

2a) Stock status: $B/B_{MSY} > 1$

$F_{OFL} = F_{MSY}$

$F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%})$

2b) Stock status: $\alpha < B/B_{MSY} \leq 1$

$F_{OFL} = F_{MSY} \times (B/B_{MSY} - \alpha)/(1 - \alpha)$

$F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%}) \times (B/B_{MSY} - \alpha)/(1 - \alpha)$

2c) Stock status: $B/B_{MSY} \leq \alpha$

$F_{OFL} = 0$

$F_{ABC} = 0$

3) Information available: *Reliable point estimates of B, $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$.*

*3a) Stock status:* $B/B_{40\%} > 1$

$F_{OFL} = F_{35\%}$

$F_{ABC} \leq F_{40\%}$

*3b) Stock status:* $\alpha < B/B_{40\%} \leq 1$

$F_{OFL} = F_{35\%} \times (B/B_{40\%} - \alpha)/(1 - \alpha)$

$F_{ABC} \leq F_{40\%} \times (B/B_{40\%} - \alpha)/(1 - \alpha)$

*3c) Stock status:* $B/B_{40\%} \leq \alpha$

$F_{OFL} = 0$

$F_{ABC} = 0$

4) Information available: *Reliable point estimates of B, $F_{35\%}$, and $F_{40\%}$.*

$F_{OFL} = F_{35\%}$

$F_{ABC} \leq F_{40\%}$

5) Information available: *Reliable point estimates of B and natural mortality rate M.*

$F_{OFL} = M$

$F_{ABC} \leq 0.75 \times M$

6) Information available: *Reliable catch history from 1978 through 1995.*

*OFL =* *the average catch from 1978 through 1995, unless an alternative value is established by the SSC on the basis of the best available scientific information*

$ABC \leq 0.75 \times OFL$

### Comments on the Alaska Tier System (from Wolff and Hauge, 2008)

Compared to other fisheries around the world, the tier system provides precautious management. Stock abundances are historically high for several stocks. Most groundfish stocks are considered to be above the BMSY level and few below. The fishing mortality rate is very low compared to European stocks. The FMSY level is lower than 0.4 for all stocks in the BSAI and GoA, but for most stocks it is lower than 0.1. The history of harvest rates indicate that the stocks have been harvested at about these levels the last 10 –20 years.

As a general comparison with the European situation, the Tier system provides cautious harvest rates, is more cautious with long-lived species, is generally more cautious the less data there is, and prevents new fisheries to develop before there is a certain minimum amount of data. However some aspects were pointed out towards possible ways of improving the Tier system.

For example, some scientists pointed at some weaknesses with the Tier system: the difference between ABC and OFL is not prescribed on uncertainty and it is not necessarily more precautious down the tiers, tier 2 has never been used and the process around switching tier level has been somewhat unpredictable. They suggested that the Tier system should change to a rule that enables to take uncertainty into account in a general way, maybe exchanged with one single rule, and that more stability in TAC levels should be built into the rule. Tier 6 was criticised for its arbitrariness.

In general though, all parties seem to have confidence in the Tier system and how it is used.

## EC Policy Statements

All communications available at http://ec.europa.eu/fisheries/cfp/fishing_rules/tacs/index_en.htm

For each of the successive Policy Statement Papers from 2006 to 2011, key extracts are copied and pasted literally. All extracts below concern only the stocks not subject to management /recovery /rebuilding plans, but focuses only on the other situations.

### Fishing Opportunities for 2007, COM(2006) 499 final

This Policy Statement was the first of the series and set up the basis of the categorizing of EC stocks according to both the status of the stock and the level of scientific uncertainty. Important introductory statements are highlighted in italics.

*"Economic and social sustainability depends on biological sustainability: there are no fisheries where there are no fish. The Commission therefore places biological sustainability at the heart of decision-making in fisheries.*

*However, the Commission does not always directly translate scientific advice on sustainability into proposals for regulations, for two reasons. Firstly, scientific forecasts are at times quite uncertain and their direct application would result in substantial changes in fishing opportunities from one year to the next, which could often be greater than those necessary to achieve the needed conservation benefits. The second reason is of a political nature. Although many fish stocks are depleted or overfished, the Commission and Member States have considered that it is acceptable to take a relatively high biological risk by allowing more fishing than is sustainable in the short term, in order to maintain a certain continuity of fishing activity. Remedial measures to redress overfishing should be implemented gradually, provided that fishing mortality is steadily and gradually reduced."*

*"As a general rule, the Commission attempts to stabilise fishing opportunities by limiting changes in TACs to no more than 15% from one year to the next."*

### Stocks exploited consistently with maximum sustainable yield

**Description:** These are fish stocks where the annual fishing mortality rate is assessed as being consistent with that delivering the highest long-term yield. For these stocks the fishing mortality should be kept close to current levels, but the TAC would not be changed by more than 15% from one year to the next.

**Fishing possibility for 2007 :** a TAC set :

- to the forecast catch established by STECF as corresponding to an $F_{msy}$ proxy, but not more than 15% higher or lower than the TAC in 2006

### Stocks overexploited with respect to maximum sustainable yield but inside safe biological limits

**Description :** this category covers stocks that are not at risk of depletion due to recruitment failure in either the short or the long term but are exploited with a fishing mortality that is higher than $F_{msy}$. It also includes those stocks which are inside safe biological limits but for which it is not yet possible to identify the fishing mortality in relation to that delivering the highest yield, and those stocks that are overexploited with respect to maximum sustainable yield but for which safe biological limits have not yet been defined. For these stocks, fishing mortality should not increase and the TAC should be kept within 15% bounds. An increase in fishing mortality would be in contradiction to both the Johannesburg Implementation Plan and the precautionary approach.

**Fishing possibility for 2007 :** TAC set :

- to the forecast catch established by STECF as corresponding to the higher value of (a) an $F_{msy}$ proxy or (b) unchanged fishing mortality, but :

- not more than 15% higher or lower than the TAC in 2006.

### Stocks outside safe biological limits

**Description:** this category covers stocks that are at risk of depletion due to recruitment failure in either the short or the long term: either fishing mortality is above $F_{pa}$ or the stock size is below $B_{pa.}$, or both. This category also includes species for which few data are available but where there are strong indications based on life history parameters and fishery characteristics that current levels of fishing are unsustainable.

**Fishing possibility for 2007 :** TAC set :

- as a general rule, to the forecast catch established by STECF as corresponding to bringing the stock inside safe biological limits in 2008, but no more than 15% higher or lower than the TAC in 2006,

- however, the TAC will in no case be set at a level that will lead to an increase in fishing mortality nor to a decrease in spawning biomass, even if this means a bigger reduction in the TAC than 15%

### Stocks whose status is unknown but which are not at high biological risk

**Description:** for many stocks deterioration in the accuracy of commercial catch data has led to high uncertainty about the state of the resources, to the extent that they cannot be assessed. Some other stocks - usually of minor economic importance - are little studied and may be caught either as by-catches in other fisheries or in fisheries of local importance only. Pending better knowledge of the state of such stocks, some interim guidelines should apply.

**Fishing possibility for 2007:** Consistent with the precautionary approach, the Commission will propose measures to prevent the expansion of fisheries in situations of high uncertainty. Where recent catch levels by all Member States are substantially lower than corresponding quotas (and there is no evidence that expansion of a fishery would be sustainable) the Commission will propose a reduction in TACs towards recent catch levels. This reduction will be proposed at a rate of 20% per year, though where scientific agencies propose a different approach (such as a recent average historic catch level) this will be taken into account.

### Fishing Opportunities for 2008, **COM(2007) 295 final**

Largely base on the same as 2006, but with following adjustments  for Setting TACs for stocks for which there is no quantitative forecast in relation to precautionary limits:

### Stocks where an advice is provided by scientific agencies

*"Scientific agencies are giving advice in a less quantitative fashion using precautionary criteria, with phrases such as "effort should be reduced substantially" without a clear quantification. Advice phrased in this way will have been provided after consideration of the trends in the data and of the results of modelling exercises even though these may not have been presented. Such advice should be taken as seriously as advice given where the results of a mathematical model is presented to managers. To do otherwise would be to create an unwise constraint on the advice provided by scientists: it would not be right to require scientists to present a mathematical model in order to have their advice taken seriously. Additionally, valuable but non-quantified statements about the state of a fish stock have to be translated into practical measures".*

Taking these points into consideration, the Commission considers that the following guidelines should apply:

a) where there is an advice by STECF to limit catches at a particular level, this should be treated in the same way irrespective of whether this is accompanied by a catch forecast table – the rule of moving the TAC towards the advised catch level in steps of no more than 15% per year should be followed;

b) where there is an advice to reduce effort, STECF should be asked to measure effort levels and to advise on the level of appropriate effort, and while such studies are being carried out, the TACs should be reduced by up to 15%;

c) where there is a non-quantified indication that stock sizes are improving due to good recruitment, a 15% increase in the TAC should be applied; conversely where there is a non-quantified indication that a stock is at high risk or declining due to weak recruitment, a decrease of up to 15% should apply;

d) where there is a very strong – but non-quantified – indication that a stock is depleted and an advice for a zero catch or a reduction to the lowest possible level is provided, the Commission will propose a reduction that is as large as is compatible with any mixed fisheries considerations and with relevant social and economic considerations. If a recovery plan is in force concerning the stock, the best possible approximation to the recovery plan rules will be proposed in the light of the existing scientific knowledge. In any event, the proposed reduction will be no less than the reduction implied by general principles outlined above.

### Stocks where no scientific advice is available

For a number of stocks no biological advice or information is available from STECF. In these cases, the precautionary approach, as incorporated in the Common Fisheries Policy, can be applied without reference to scientific advice. In these cases, the guiding principle can be that no expansion of the fishery should be foreseen because there are no scientific data showing that such an expansion could be sustainable. Where current TACs are substantially higher than the real recent catches, they would be adapted towards the real catches at a rate of 15% per year.

### Fishing Opportunities for 2009, **COM(2008) 331 final**

*"Despite substantial efforts, there are no significant signs of stock recovery nor of reductions in overfishing since 2003. Fisheries management in the European Union is not working as it should and the objective of achieving long-term sustainability is not being reached."*

*"In 2007 STECF reported on the likely outcome of the rules in the Commission's Policy Statements*[7]*. The advice was broadly supportive, but pointed to two serious shortcomings.*

*The first is that the rules often prevented depleted stocks from recovering. Although the rules set the rate of fishing on a stock at a precautionary rate when the stock is at a normal level, they did not provide for reducing the rate of fishing for stocks which have already become depleted. In these situations the stocks become less resistant to fishing and the rate of fishing must be reduced if the stock is to recover. For example, the stock of cod west of Scotland declined at a rate of faster than 15% per year. TAC reductions of less than 15% per year failed to protect this stock. The second shortcoming is that the rules could prevent industry from taking advantage of increases in available catches from stocks that have recovered. Stocks may be able to recover faster than 15% per year, but the rules limit TAC increases to this figure. Stocks of herring, for example, have recovered from low levels at much faster rates than 15% annually."*

*"Changes to the rules are necessary and new rules have been developed. For stocks that are depleted to a low level of biomass, it is now proposed to reduce fishing mortality by up to 30% per year, while not changing the TAC by more than 20%. The reductions should be kept until the fishing mortality has been successfully reduced to the level where STECF advises that the highest yields can be taken in the long term. For stocks that have recovered above the level that will let the highest yields be taken, the 15% limit on TAC increases will be widened to 25%. Also, where STECF advises a zero catch, TACs should be reduced by at least 25%. Widening the interval through which TACs can be changed means that larger decreases can be taken when needed, but also that larger increases can be made if stocks increase adequately."*

As a result, the Policy Statement suggested 11 categories:

| Scientific advice | Action to take in setting TAC |
| --- | --- |
| Stock exploited at the maximum sustainable yield rate. | Aim to set the TAC to the forecast catch corresponding to the fishing mortality that will deliver the highest yield in the long term, **but** do not change the TAC by more than 25%. |
| Stock overexploited compared to maximum sustainable yield but inside safe biological limits. | Aim to set the TAC to the higher value of (a) to the forecast catch corresponding to taking the highest yield in the long term[11], or (b) fishing at an unchanged mortality rate, **but** do not change the TAC by more than 15%. |
| Stock outside safe biological limits | Aim to set the TAC to the forecast catch that will result in a 30% reduction in fishing mortality rate, **but** do not decrease the fishing mortality so far as to prejudice long-term yields[11] **and** do not reduce the TAC by more than 20%. |
| Stock is subject to long-term plan and scientists advise on the catch that corresponds to the plan. | The TAC must be set by following the relevant plan. |
| Stock is short-lived and a one-year forecast cannot be provided. | A provisional TAC is set and will be changed when new information is available during the year. |
| State of the stock not known precisely and STECF advises on an appropriate catch level. | Aim to set the TAC according to STECF advice **but** do not change the TAC by more than 15%. |
| State of the stock not known precisely and STECF advises to reduce fishing effort. | The TAC should be reduced by up to 15% and STECF should be asked to advise on the appropriate level of effort. |
| State of the stock not known precisely and STECF advises the stock is increasing. | The TAC should be increased by up to 15%. |
| State of the stock not known precisely and STECF advises the stock is decreasing. | The TAC should be decreased by up to 15%. |
| STECF advises a zero catch, a reduction to the lowest possible level or similar advice. | The TAC should be reduced by at least 25%. Recovery measures should be implemented including effort reductions and introduction of more selective fishing gear. |
| There is no STECF advice. | TACs should be adjusted towards recent real catch levels but should not be changed by more than 15% per year **or** Member States should develop an implementation plan to provide advice within a short time. |

## Fishing Opportunities for 2010, COM(2009) 224 final

*"Where long-term plans are not yet in place, TAC decisions are taken on the basis of annual scientific advice from ICES and STECF, the latter including biological as well as socio-economic aspects. Rules have been developed for TAC setting so that fair treatment is assured and as much stability as possible is provided to the industry.*

*These rules will continue to apply, but with some changes as required by the latest scientific advice."*

*"In 2008 STECF reported on the likely outcome of the rules in the Commission's Policy Statement. The advice was broadly supportive in that TACs set according to categories 1 till 3 (stocks with analytical assessment) often lead to stock rebuilding and recovery. STECF however pointed out one serious shortcoming: for stocks for which an analytical assessment is not available (categories 6 to 9 and 11) setting a TAC in line with a trend in catch per unit of effort (cpue) will not maintain a healthy stock and was not recommended. (…). "*

*"Referring now specifically to stocks where scientific advice is lacking (category 11) because of inaccurate data from the fishing sector on landings, as well as problems in obtaining discards and effort data. This problem seems to be getting worse: poor data leads to poor decisions, which in turn means poor conservation status and depleted stocks. Thus if data is not improved, then a precautionary approach will be followed and consequently more stringent rules will be applied."*

The adjustments from last year are highlighted in bold in the table below.

| Category | Scientific advice | Action to take in setting TAC |
|---|---|---|
| 1 | Stock exploited at the maximum sustainable yield rate. | Aim to set the TAC to the forecast catch corresponding to the fishing mortality that will deliver the highest yield in the long term, **but** do not change the TAC by more than 25%. |
| 2 | Stock overexploited compared to maximum sustainable yield but inside safe biological limits. | Aim to set the TAC to the higher value of (a) to the forecast catch corresponding to taking the highest yield in the long term[12], or (b) fishing at an unchanged mortality rate, **but** do not change the TAC by more than 15%. |
| 3 | Stock outside safe biological limits | Aim to set the TAC to the forecast catch that will result in a 30% reduction in fishing mortality rate, **but** do not reduce the TAC by more than 20% as long as fishing mortality will not increase. |
| 4 | Stock is subject to long-term plan and scientists advise on the catch that corresponds to the plan. | The TAC must be set following the relevant plan. |
| 5 | Stock is short-lived and a one-year forecast cannot be provided. | A provisional TAC is set and will be changed when new information is available during the year. |
| 6* | State of the stock not known precisely and STECF advises on an appropriate catch level. | Aim to set the TAC according to STECF advice **but** do not change the TAC by more than 15%. |

| | | |
|---|---|---|
| 7* | State of the stock not known precisely and STECF advises to reduce fishing effort. | The TAC should be reduced by up to 15% and STECF should be asked to advise on the appropriate level of effort. |
| 8* | State of the stock not known precisely and STECF advises the stock is increasing. | The TAC should be increased by up to 15%. |
| 9* | State of the stock not known precisely and STECF advises the stock is decreasing. | The TAC should be decreased by up to 15%. |
| 10 | STECF advises a zero catch, a reduction to the lowest possible level or similar advice. | The TAC should be reduced by at least 25%. Recovery measures should be implemented including effort reductions and introduction of more selective fishing gear. |
| 11 | There is no STECF advice. | TACs should be adjusted towards recent real catch levels but should not be changed by more than 15% per year **or** Member States should develop an implementation plan to provide advice within a short time. |

* This rule may be subject to changes. The Commission has requested ICES to advice on possible new options as set out in Annex III. The final rule to be applied will depend on the outcome of that advice.

Fishing Opportunities for 2011, **COM(2010)241 final**

*"By 2011, time is running out for reaching Maximum Sustainable Yield (MSY) targets by 2015. Many important stocks are now under long-term plans that have $F_{msy}$ objectives. These plans should be implemented, and for both new plans and for existing plans that need revision to align their targets on MSY, the Commission will make appropriate $F_{msy}$ –based3 proposals."*

*"Some adaptations to the working method used previously are necessary in order to move towards $F_{msy}$ (Annex III). For stocks which are overfished but are inside safe biological limits, adaptations of the TACs will be proposed such that MSY fishing mortality will be reached by 2015. The limit on TAC changes will be increased from 15% to 25% so as not to prejudice the attainment of the MSY objective. For stocks which are overfished and are also outside safe biological limits, the existing rule will be modified so as to move towards the MSY objective by 2015.*

*The 30% minimum decrease in fishing mortality would be retained where necessary."*

In the following table, changes with respect to rules used previously are marked in bold.

| Category | Scientific advice | Action to take in setting TAC |
|---|---|---|
| 1 | Stock exploited at the maximum sustainable yield rate. | Aim to set the TAC to the forecast catch corresponding to the fishing mortality that will deliver the highest yield in the long term, but do not change the TAC by more than 25%. |
| 2 | Stock overexploited compared to maximum sustainable yield but inside safe biological limits. | Aim to set the TAC to the higher value of (a) to the forecast catch corresponding to taking the highest yield in the long term[10], or (b) **the catch corresponding to reducing the fishing mortality rate by one-quarter of the difference between the current fishing mortality and the rate that would provide the highest yield in the long term,** but do not change the TAC by more than **25%**. |
| 3 | Stock outside safe biological limits | **Aim to set the TAC to the highest value of (a) the forecast catch corresponding to taking the highest yield in the long term, or (b) the catch corresponding to reducing the fishing mortality rate by the larger value of**<br><br>**(i) 30%**<br><br>**(ii) one quarter of the difference between the current fishing mortality and the rate** |

| | | |
|---|---|---|
| | | **that would provide the highest yield in the long term**<br><br>**but do not reduce the TAC by more than 30% as long as fishing mortality will not increase.** |
| 4 | Stock is subject to long-term plan and scientists advise on the catch that corresponds to the plan. | The TAC must be set following the relevant plan. **This category overrides other categories.** |
| 5 | Stock is short-lived and a one-year forecast cannot be provided. | A provisional TAC is set and will be changed when new information is available during the year. |
| 6* | State of the stock not known precisely and STECF advises on an appropriate catch level. | Aim to set the TAC according to STECF advice **but** do not change the TAC by more than 15%. |
| 7* | State of the stock not known precisely and STECF advises to reduce fishing effort. | The TAC should be reduced by up to 15% and STECF should be asked to advise on the appropriate level of effort. |
| 8* | State of the stock not known precisely and STECF advises the stock is increasing. | The TAC should be increased by up to 15%. No increase in fishing effort §. |
| 9* | State of the stock not known precisely and STECF advises the stock is decreasing. | The TAC should be decreased by up to 15%.<br><br>Decrease fishing effort §. |
| 10 | STECF advises a zero catch, a reduction to the lowest possible level or similar advice. | The TAC should be reduced by at least 25%. Recovery measures should be implemented including effort reductions and introduction of more selective fishing gear. |
| 11 | There is no STECF advice, or the state of the stock is not known precisely and STECF does not advise on whether the stock is increasing or decreasing. | TACs should be adjusted towards recent real catch levels but should not be changed by more than 15% per year **or** Member States should develop an implementation plan to provide advice within a short time.<br><br>No increase in fishing effort §. |

* This rule may be subject to changes. The Commission has requested ICES to advice on possible new options as set out in Annex IV. The final rule to be applied will depend on the outcome of that advice.

### Fishing Opportunities for 2012, COM(2011) 298 final

*"The aim of setting levels of Total Allowable Catches (TACs) and quotas and the fishing effort levels for European fisheries for 2012 should be to phase out overfishing. Overfishing does not necessarily mean that a stock is at risk of extinction or collapse - it simply means that as much fish or even more could be caught with less fishing activity."*

*While so little is known about many stocks, more cautious TACs should be set where uncertainty is greater.*

*Immediate redress would cause serious disruption if fishing were to be prohibited on all stocks whose status is currently unknown. Instead, four courses of action should be proposed.*

- When scientific advice on overfishing is unavailable, a reduction of 25% in the TAC and/or in the fishing effort levels should be proposed, unless scientific advice indicates that a bigger reduction is necessary because of short-term risks to the stock.

- Member States should devote sufficient resources and urgently deliver the necessary information to allow the state of the stocks to be estimated.

- Scientific agencies will be tasked with supporting the resolution of these problems as a matter of urgency, bearing in mind that the knowledge base must be provided by the Member States.

- Indicators from commercial fisheries and from the scientific surveys should be developed to provide some robust rules to guide fisheries towards sustainable exploitation of resources even in data-poor situations.

TACs should be set according to scientific advice based on comprehensive data and quantitative analysis and forecasts according to the "MSY framework". When such advice is available it should be directly used to fix levels of quotas or fishing effort, though a gradual implementation of this framework by 2015 could be accepted where this is compatible with the advice.

Where there is no scientific advice, or where the data available are inadequate to calculate the size of the stock and the appropriate catch, there is a need to be more careful. A 25% reduction in TAC should be applied and Member States should take urgent steps to identify the appropriate fishing rate.

## Some points of discussion

The Alaska Tier system is an interesting system, because it shows that it has been possible to develop a generic rule based system with mechanisms allowing to i) cover all types of species caught in the region, regardless of the level of scientific knowledge, ii) avoid unregulated development of fisheries without proper monitoring of the resources, iii) account for some sort of mixed-fisheries and multi-species considerations in a simple and transparent manner, iv) consider both targets (MSY) and limits (OFL) reference points, v) insure stability, consistency and transparency in the management process, and from there, gain support from stakeholders. While it is recognized that the rules themselves could be improved in some aspects, the principle of rule-based management is not challenged.

The EC Policy statements have aimed at developing rule-based TAC setup along similar paths. From 2006 to 2010, the outcomes of the EC communication papers reflect an interesting evolving process, where the EC has established clear principles, and from there, recognizing the diversity of situations in terms of level of scientific knowledge and the unavoidable and often irreducible uncertainties in the state of nature, has suggested up to 11 categories with corresponding rules for setting the TACs. Over time, these rules have evolved due to feed-back interactions and communications with scientific agencies and stakeholders. It is however clear that these rules hadn't reached their mature level yet, at they have been continuously refined and adjusted every year. As a matter of comparison, one can keep in mind that in Alaska, first developments took place with the Magnus-Stevenson Act in 1976, but were finalized around 1998 only, i.e. it took two decades to reach a definitive common ground.

The category 11 of EC Policy Statement present similar precautionary mechanisms at the Tier 6 of the Alaska rules, i.e. it prevents any development of a fisheries without a minimum basis of scientific knowledge, and acts therefore as a major incentive for contributing to scientific knowledge. Illustrations of this are to be found in the increasing development of numerous collaborative scientific programs and joint surveys with scientists and fishermen. While this was initially mostly dealt with at the local/national level, a higher level has been reached recently during the Joint ICES-RACs initiative on data deficiencies (WKDDRAC), which was kicked-off in January 2011 in order to establish workplans for improving the most acute data deficiencies in the North Sea and North-Western areas, and from there hopefully lift some stocks away from Category 11 and its decreasing TAC rule. This initiative represented a real break-through in the history of data collection and collaboration between scientists and the fishing industry. Outcomes from the two meetings held in 2011 around this joint initiative clearly showed that the focus was not on challenging the principles behind the rules of the 2010 Policy Statement, but on making the best out of it by contributing to better knowledge in order to get higher TACs.

The 2011 Consultation represents however an abrupt change in the relatively short history of the EC Policy Statements. The 11 rules have been replaced by 3, of which the two first deal with stocks with analytical assessments and established fishing mortality levels, while the third, which then covers the majority of EC stocks, suggest to reduce TAC by 25% for all stocks, regardless of the actual levels of scientific knowledge. There is no distinction between stocks with some knowledge on abundance levels, and stocks with much less information. Neither does this acknowledge, as in 2008, that qualitative advice is often the result of in-depth scientific work which then"*should be taken as seriously as advice given from a mathematical model*".

However, the Policy Statement suggest that "*Indicators from commercial fisheries and from the scientific surveys should be developed to provide some robust rules to guide fisheries towards sustainable exploitation of resources even in data-poor situations*", which seems though not very far in essence from the idea behind the previous categories 6 to 9. These previous categories 6 and 9 had actually already embedded some suggestion for formulating quantitative rules on e.g. survey trends, such as "*If the average estimated abundance in the last two years exceeds the average estimated abundance in the three preceding years by 20% or more, a 15% increase in TAC applies*" .

## Conclusion

On the basis of this review, I conclude that the main interest of such rule-based management is to provide transparency, fairness and predictability in the management decision process. This in turn should insure stability and commitment from stakeholders as seen in Alaska and now increasingly in Europe. All recent research on good governance practices and paths towards sustainable fishing underline the importance of clarity of management objectives and long-term visions, and the increasing sustainability observed for stocks subject to long-term management plans illustrates this clearly. It is therefore of major importance to be able to establish similar mechanisms for the numerous data-poor stocks, in order to reach sustainability under current conditions of knowledge and limited scientific resources.

The diversity of rules between Alaska and EC shows that the technical design of such rules is not universal and there is likely no single better way of approaching these. It is obvious that such rules cannot be fully agreed upon from the first year of implementation, and it requires consultations and adjustments over the first period of time to evolve before reaching a mature stage. I believe that the Policy Statement in 2010 was actually developing in a right direction, moving along the processes that insured the commitment to Alaska Tier system in more than 15 years. While the 11 categories and their corresponding rules could certainly be further improved, I believe that their principles were gaining increasing acceptance both in the scientific community and among the fishing industry. These rules could have in the near future set the basis for establishing long-term management plans for most stocks without analytical assessment falling within the categories 6 to 9, while providing incentives for developing scientific knowledge for the stocks falling into category 11.

I consider though, that these positive mechanisms have been largely broken in the 2011 Policy Statement, which in essence will place great pressure on the scientific community to deliver more analytical assessments, in spite of the current difficulty to provide relevant advice in a number of cases. While good data are a necessary condition for getting adequate scientific knowledge, providing more and better data is certainly not sufficient for reaching analytical assessments for all stocks. A number of scientific uncertainties are in essence irreducible, or only marginally reducible with a great deal of additional dedicated resources. Scientific resources (in person-time and money) are meanwhile increasingly limiting, and therefore the objectives embedded in the 2011 Policy Statement should be replaced in an objective cost-benefit analysis.

In conclusion, I consider that the absence of analytical assessment for the cod stocks in Irish Sea, Kattegat and West of Scotland should not prevent implementing a long-term management plan for these stocks. However, given that the uncertainties that currently hinder stock assessments will likely not disappear in the near future, a management plan could be based on other objectives and criteria than the current F-based design. That would likely make the LTMP more pragmatic and operational, which in turn would likely facilitate the implementation and ultimately beneficiate the sustainability of these stocks. More creative rules could be implemented based on existing examples as those reviewed here, involving survey-trends and life history traits, as well as on the improved ICES MSY framework.

# Annex 5 Effort-based management in mixed-fisheries : Experience from the Faroese Islands

Working Document to STECF-ICES WKROUNDMP 2011

Clara Ulrich, version 15 June 2011

During the 2011 February meeting of WKROUNDMP, it was suggested to provide additional general reviews on the effectiveness of recovery plans and effort management. In particular, the case of the fisheries management in the Faroese Islands provide some interesting insights, as this is practical example where pure effort-based management is implemented in a mixed demersal fishery context, without single-stocks TAC.

The current document is directly extracted from the review and the analyses performed and published by Baudron et al. (2010)[2], which at the time they were initiated used data up to 2005 only (ICES, 2006). Due to time constraints, it has unfortunately not been possible to fully update the general overview of the Faroese system over the most recent years. However, according to J. Boje (pers.comm.), it is not believed that there has been major changes in the system in the most recent years so the conclusions below may still hold.

## 1. General overview of the Faroese effort management system

The Faroe Islands have received growing interest as a case study where relevant lessons could be learned (Nielsen *et al*., 2006; Jákupsstovu *et al*., 2007; Løkkegaard *et al*., 2007). In the mid-1990s, the TAC system in place was rejected by the fishing industry and the authorities because it did not lead to satisfactory management. It resulted in extensive discarding when single-species quotas were filled. Therefore, owing to the general dissatisfaction, the Faroese Parliament developed a new management system in close cooperation with the fishing industry for all vessel groups targeting demersal stocks on the Faroe plateau, and implemented it from 1996. This new system (hereafter referred to as one of total allowable effort, TAE) consists of individual transferable effort quotas (fishing days) for specific fleet categories (small trawlers, pair trawlers, longliners, and coastal fishing vessels operating in "The Ring", in waters shallower than 200 m). Additional measures such as area closures during the spawning seasons, area restrictions for larger vessels, and minimum gear mesh sizes were implemented too.

In the first year of implementation, the initial allocation of fishing days was based on an estimated historical allocation from data on partial fishing mortalities. It was also estimated that sustainability of the fisheries could be achieved by a target fishing mortality ($F$) of 0.45 for each stock, corresponding to an average annual harvest of approximately one-third of the spawning stock (ICES, 2006; Jákupsstovu *et al.*, 2007). Subsequently, the number of fishing days allocated has been regulated each year based on ICES advice and input from the fishing industry.

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[2] Baudron, A., Ulrich, C., Nielsen, J. R., and Boje, J. 2010. Comparative evaluation of a mixed-fisheries effort-management system based on the Faroe Islands example. – ICES Journal of Marine Science, 67: 1036–1050.

The Faroe Islands fisheries represent an innovative and unique system of a mixed groundfish fishery regulated by individual transferable fishing days. It is a relatively pure effort-regulation system, which also has been in force for a long time compared with other effort-regulation systems worldwide (Nielsen *et al*., 2006). After ten years of implementation it is possible to assess empirically the effects of this management system in practice (Jákupsstovu *et al*., 2007). These last authors described the key issues of the system and concluded that Faroese effort management had not achieved all its objectives. Management had failed to maintain average *F* at 0.45 over the years. ICES (2006) did not consider this target to be consistent with its interpretation of the precautionary Approach; ICES bases its advice on the precautionary approach that corresponds to a value of *F* of 0.35. Since the introduction of the effort system, the total number of fishing days allocated has been reduced by some 15 % in total, i.e. less than 2% per year since implementation, significantly less than advised by ICES for the same period (ICES, 2008).

The allocated fishing days are still not fully utilized, however, which suggests that the initial effort allocation was too high to constrain *F* to the target. In practice, effort management did not act as a restrictive and reactive management tool, but rather as a conservative *status quo*.

One of the main assumptions behind implementing effort management, that fishers would switch their target automatically according to the relative availability of the stocks, has not been verified (Jákupsstovu *et al*., 2007). Most fishers opportunistically target cod (*Gadus morhua*), which is the most valuable species. Changes to targeting behaviour towards stocks that are more abundant takes place progressively, so leading to ongoing high levels of mortality for the less abundant stocks, especially if their value is high or if prices increase while catches decline.

Effort regulation provides incentives for fishers to increase their catchability because they are limited by the time they are allowed to fish (Nielsen *et al*., 2006). In addition, catchability is likely to increase over time because of so-called technological creep and increased knowledge of best fishing practice. However, it has proven difficult to demonstrate that changes in catchability were associated with the introduction of the effort system (Jákupsstovu *et al*., 2007), because of the influence of environmental conditions. There is considerable interannual variation in exchange rates between the warm, saline upper water layer and cold, less saline deeper water, leading to great variability in productivity between areas and years where primary production may vary by up to a factor of five. Environmental variability has a significant impact on fish stock dynamics and trends and may be considered as one of the main drivers of fluctuations in the stocks, with respect to both recruitment and growth (Steingrund and Gaard, 2005; ICES, 2006). Primary productivity seems to be negatively correlated with the catchability of longlines, suggesting that cod approach longline bait more often when natural food abundance is low (ICES, 2008). Consequently, natural factors may impact catchability to a greater extent than technological ones.

## 2. Main results of MSE analyses

A Management Strategy Evaluation (MSE) model was developed by Baudron et al. (2010) to compare an effort-management system (TAE) based on the Faroese example with a TAC system as currently applied in EU fisheries, both in a single-stock approach for the three main demersal stocks (cod, haddock, saithe) in isolation and a mixed-fisheries and fleet-based context considering the three stocks together.

### 2.1 Single stock approach

We could not ascertain whether TAEs led systematically to more biological robustness than TACs. In a single-species approach over a ten-year projected period, this was only true for the most depleted stock, where mean biomass was higher and uncertainty lower than with the TAC scenarios. For the other two stocks, and without accounting for mixed-fishery interactions, single-species TACs performed equally well or sometimes better than a TAE system.

Effort-based HCRs were expected to be more biologically robust than catch-based HCRs, because they are less dependent on uncertainty in growth, recruitment, and the results of stock assessments. There were a number of simulations where the TAC system induced large fluctuations in $F$, along with poor performance of the assessment method. However, it was not clear from the results that the TAE was more biologically robust when looking at each stock in isolation. One key issue in a TAE system is the great uncertainty in catchability estimates, which blurs the relationship between $E$ and $F$. The uncertainty in this parameter is comparatively higher than the uncertainty in biological forecast parameters, owing to the generally poor relationship between $E$ and $F$, and the potentially great impact of environmental variables (Jákupsstovu *et al.*, 2007). This fact undermines the ability of a TAE to control $F$ effectively. This issue is a generic feature in any effort-management system, but in the particular context of the Faroese-type fisheries studied here, where nominal effort is high and lacking in flexibility, this high variability in catchability contributes substantially to the risks of non-sustainability of the system.

### 2.2 Mixed fisheries approach

In a mixed-fisheries context, the TAE system would often be more sustainable than the TACs if it was flexible enough in following the year-to-year variability in scientific recommendations. Buisman *et al.* (2010) observed that an effort control system does not seem to improve the economic performance of the Faroese fleet. Setting the effort level at an intermediate level, but with additional measures to protect the depleted stock, would appear to be an acceptable compromise between sustainability and optimal yield, provided that there is some spatio-temporal separation of stocks on some fishing grounds. In reality, the Faroe Islands also have an advanced system of technical measures ensuring clear spatial separation between gears, but these need also be designed carefully in order to ascertain the best exploitation scenarios for the various stocks.

## 3. Discussion and conclusion

The case of management of the Faroese fisheries is particularly interesting. These fisheries have been experiencing the same problems of managing mixed fisheries with TACs as in other parts of the western world. However, their smaller scale, their closure to foreign fleets, their uni-jurisdictional management, the importance of fisheries to society, and some co-management schemes between industry, scientists, and management bodies have made it possible to establish new governance rules and new innovative management systems.

However, even under these favourable conditions, ten years of experience have proved that the system has not achieved all its conservation objectives (Jákupsstovu *et al.*, 2007), partly because the system has not been effectively restrictive for long enough (Løkkegaard *et al.*, 2007). Recruitment to the stocks has not been low during the period of analysis, so maintaining the stocks at good productivity, but the initial effort agreed in 1996 was set at a too high a level, which in practice only prevented the effort increasing but did not actually lower it. Since then, there has been resistance from industry to decreasing the amount of effort authorized, but the current decrease in the cod stock has led to recent proposals for drastic reductions which are impacting the whole Faroese society. This underlines the importance of the initial design of a management system.

Our results suggest that effort management seems to be appropriate, but that some interannual flexibility in the system would appear to be the best compromise between short- and long-term objectives, as well as between biological sustainability and economic return. This would allow adapting management to natural fluctuations in stock abundance and uncertainty in the catchability parameter.

In conclusion, we showed that the main issue was not effort management itself, but rather its inability to adjust to scientific recommendations and to variability and trends in catchability. This in turn is linked to the fact that the initial effort was set by Faroese authorities too high, and it could not be reduced easily thereafter. A sustainable TAE system is accommodated if the initial effort level is set sustainably. Only then, and allowing for adequate year-on-year flexibility, the TAE would appear to be a more sustainable and economically robust management strategy than TAC-based management, considering the fluctuations in the single-species HCR and the extensive discarding this could create.

## 4. References


Baudron, A., Ulrich, C., Nielsen, J. R., and Boje, J. 2010. Comparative evaluation of a mixed-fisheries effort-management system based on the Faroe Islands example. – ICES Journal of Marine Science, 67: 1036–1050.

Buisman, E., Frost, H., Hoff, A., Murillas, A., and Powell, J. P. Evaluating economic efficiency of innovative management regimes. *In* Comparative Evaluations of Innovative Fisheries Management: Global Experiences and European Prospects. Ed. by K. H. Hauge and D. C. Wilson. Springer, Dordrecht (in press).

ICES. 2006. Report of the NorthwesternWorking Group, 25 April – 4 May 2006. ICES Document CM 2006/ACFM: 26.

ICES. 2008. Report of the Northwestern Working Group, 21–29 April 2009. ICES Document CM 2008/ACOM: 03.

Jákupsstovu, S. H. í, Cruz, L. R., Maguire, J-J., and Reinert, J. 2007. Effort regulation of the demersal fisheries at the Faroe Islands: a 10-year appraisal. ICES Journal of Marine Science, 64: 730–737.

Løkkegard, J., Andersen, J., Boje, J., Frost, H., and Hovgård, H. 2007. Report on the Faroese Fisheries regulation – the Faroe Model. Report of the Institute of Food and Resource Economics. University of Copenhagen, 193.

Nielsen, J. R., Sparre, P. J., Hovgård, H., Frost, H., and Tserpes, G. 2006. Effort and capacity-based fisheries management. *In* The Knowledge Base for Fisheries Management, pp. 163–212. Ed. by L. Motos, and D. C. Wilson. Elsevier, Amsterdam. Developments in Aquaculture and Fisheries Science, 36.

Steingrund, P., and Gaard, E. 2005. Relationship between phytoplankton production and codproduction on the Faroe Shelf. ICES Journal of Marine Science, 62: 163–176.

## Annex 6 The relationship between F and Effort

Sarak Kraak, Marine Institute, Ireland

The cod plan, in its aim to control fishing mortality (*F*) on cod, heavily relies on the assumption of proportionality between fishing effort and *F*. Fishing effort is a product of applied fishing capacity (e.g. in kW) and fishing time (e.g. in hours). The proportionality assumption may seem valid intuitively – when either component of fishing effort is doubled or halved, its effect on the stock is also doubled/halved – but it actually depends on many hidden assumptions which are usually violated ('all else being equal' is such a tacit assumption).

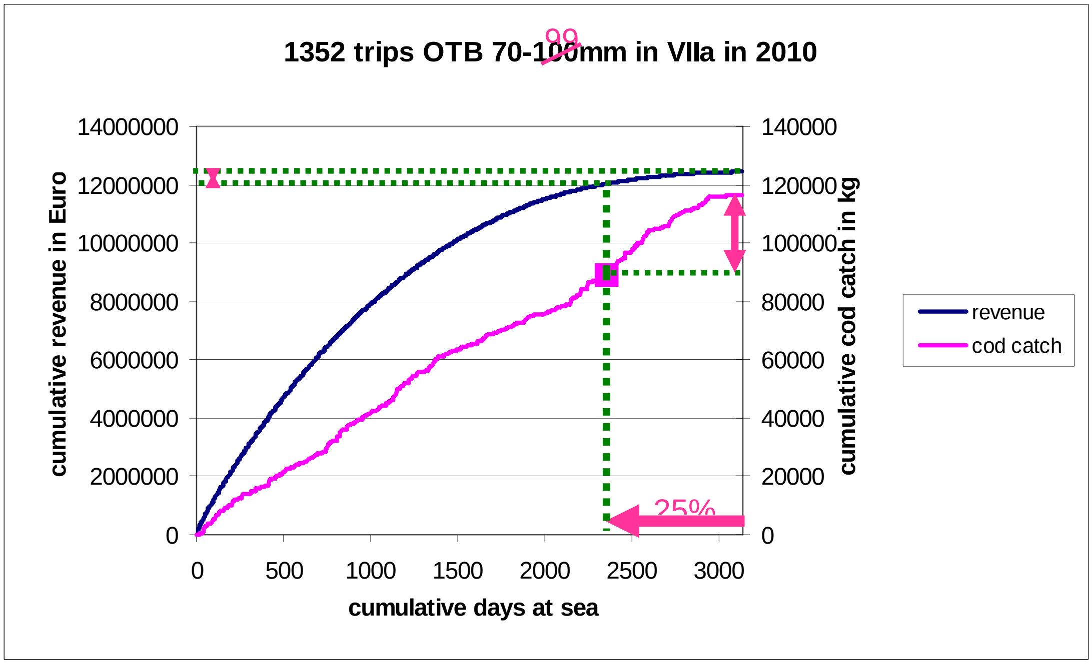
Some factors influencing the validity of this assumption and deteriorating the proportional relation have been identified – and quantified in the case of the Dutch North Sea beam trawl fishery for flatfish – by Rijnsdorp et al. (2006). In their study, the partial *F* exerted per unit effort (*F*pue) by a vessel depended on *skipper skills*, *auxiliary equipment*, as well as the *area* and the *season* of the fishing operation. They concluded that management-imposed reductions in effort, therefore, might not translate directly into a proportional reduction in *F*. The relationship between effort and *F* was explored for each vessel by plotting the cumulative predicted values of *F*pue against cumulative effort, after sorting the weeks in descending order of *F*pue (or revenue per unit of effort). The authors assumed that fishers can restrict their effort predominantly in those weeks and areas for which they expect a low catch rate. The more convex this relation is, the better a fisher can select an inefficient week/area to skip fishing when they face effort reductions. A similar approach was taken by Kraak et al. (2008) and Van Oostenbrugge et al. (2008) studying the same fishery and quantifying the non-proportional, convex, relation between *F* and effort. Kraak et al. (2008) reported predictable effects of *vessel*, *gear*, and *month* on the efficiency in terms of net revenues per unit of effort. Thus, it was concluded, under effort restriction fishers may decide to cancel specific month–vessel–gear combinations, i.e. the least efficient trips, to maximize net revenues. Thus, net revenues – and fishing mortality! – would decrease less than proportionally with the restricted effort, by concentrating trips in the most efficient seasons, and by trading quota or hp-days from less-efficient vessels to more-efficient ones. In the long term, this may even cause less-efficient vessels to be withdrawn from the fishery.

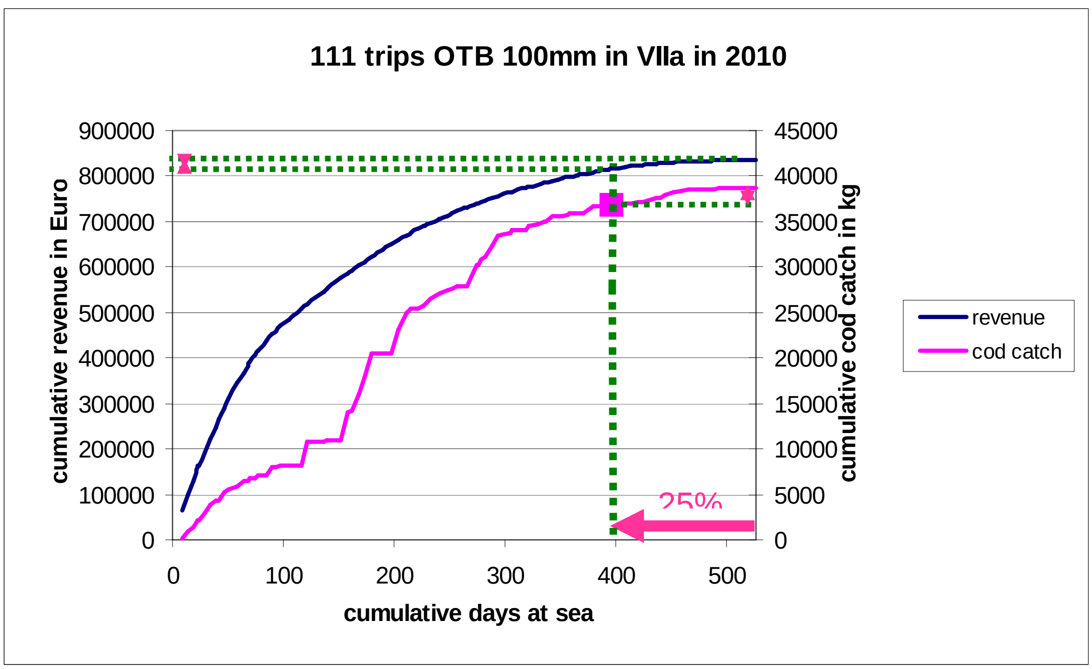
Quirijns et al. (2008) pointed out the variability of targeting behaviour, i.e. the extent to which a certain species is targeted or avoided, through spatiotemporal effort allocation choices, gear choices, and other business decisions. Changes in spatial distribution of the fleet relative to that of a fish stock will result in changes in the relation between effort and *F*. This may be particularly relevant in the case of mixed fisheries where changes in market conditions, (fuel) costs of fishing, or management measures may result in changed incentives and thus in changed targeting behaviour. Another effect is that spatial distribution of a stock may contract with declining population biomass, without affecting the fish densities in the core habitat of the species. When fishers are mainly fishing these core habitats, contraction of the spatial distribution will result in a 'hyper stability' of the catch rate (Harley et al., 2001). Thus, if fishers faced with effort reductions 'contract' their activity to these core habitats, they may still achieve high catches despite the reduced effort. All in all, it is likely that fishers change their targeting behaviour, e.g. through spatiotemporal effort allocation, in response to management measures and changes in (economic) incentives. On the one hand, if the management measure is reduced fishing effort, fishers can shift their effort to areas and times with high catchability (e.g. high relative abundance) (leading to a convex relation between effort and *F*). On the other hand, if quota are reduced for some species but not (as much) for others, fishers may try to avoid catching the first species by shifting their activity to areas/times with low catchability for that species, resulting in lower catches with the same effort (in this case the non-proportional relation between effort and *F* on that species would be concave rather than convex).

Furthermore, Poos and Rijnsdorp (2007) provided evidence for interference competition in the Dutch beam trawl fleet and estimated that a doubling of the vessel density within an ICES rectangle would reduce the catch rate by approximately 10%. This effect would also deteriorate proportionality between *F* and effort and make the relation convex (that is for any effort reduction *F* will decrease less than proportional).

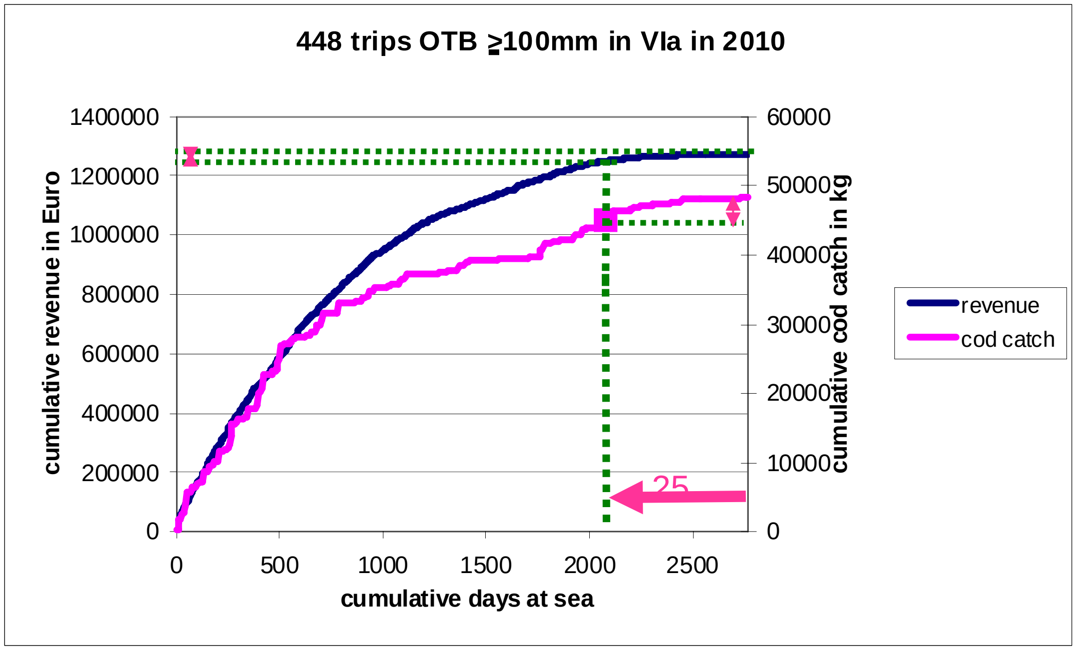
We conclude that in general it is very unlikely that effort reductions will lead to anything close to proportional reductions in *F*; under effort reductions it is most likely that the non-proportional relation is convex, implying that *F* decreases to a *lesser* extent than effort. In that case greater effort reductions than those stipulated in the plan are needed to achieve the reductions in *F* prescribed in the plan's HCR. Various attempts to quantify and predict the relation in the case of the North Sea flatfish fishery have been presented here. Similar studies should be undertaken to predict the amount of effort reduction needed to achieve a certain required reduction in cod *F*, or to predict the reduction in cod *F* under a given effort reduction.

A 'quick and dirty'* illustration is given here in order to gain some idea of the lower bounds of expected % reduction in *F* under a given % reduction in effort. We analyzed logbook data from three groups of trips: all Irish 2010 trips with OTB 70-99 mm mesh in VIIa; all Irish 2010 trips with OTB 100 mm mesh in VIIa; and all Irish 2010 trips with OTB 100+ mm mesh in VIa. In each case, separately, we ordered the trips by descending efficiency, i.e. by descending revenue-per-unit-effort. Then, under the extreme assumptions that fishers (i) maximize fleet revenues and (ii) have perfect knowledge, and (iii) are not restricted by quota, we simulated what would have happened if the 25% least efficient trips would not have taken place (disregarding the identity of individual vessels/skippers involved). The graphs show that in all three cases revenues would have been maintained at 97%-98% of the actual revenues, but that cod catches would have been reduced to 77%, 95%, and 93% of the actual catches for the three respective groups (for illustration: under a starting *F* of 0.7-0.8, these would then correspond to reductions in *F* of respectively 30%-32%, 7%-8%, and 10%). We conclude that, depending on fisher behaviour, a 25% effort reduction may result in anything between a few % and >25% reduction in *F*.




*In a small number of cases no price information was available; if price information was available for the same port the average price for that port was taken for the missing value; if no price information was available for that port the average price over all ports (within area) was taken for the missing value. For three species there was no price information at all, concerning respectively 1, 1, and 3 trips. These species constituted <1% of the catch of the respective trips and were deleted from the analyses.




## References


Harley, S.J., Myers, R.A. and Dunn, A. 2001. Is catch-per-unit-effort proportional to abundance? Can. J. Fish. Aquat. Sci. 58: 1760–1772.

Kraak, S. B. M., Buisman, F. C., Dickey-Collas, M., Poos, J. J., Pastoors, M. A., Smit, J. G. P., van Oostenbrugge, J. A. E., Daan, N. 2008. The effect of management choices on the sustainability and economic performance of a mixed fishery: a simulation study. ICES Journal of Marine Science, 65: 697-712.

Poos, J.J., Rijnsdorp, A.D., 2007. An "experiment" on effort allocation of fishing vessels: the role of interference competition and area specialization. Can. J. Fish. Aquat. Sci. 64, 304–313.

Quirijns, F. J., Poos, J. J., and Rijnsdorp, A. D. 2008. Standardizing commercial CPUE data in monitoring stock dynamics: accounting for targeting behaviour in mixed fisheries. Fisheries Research, 89: 1-8.

Rijnsdorp, A. D., Daan, N., and Dekker, W. 2006. Partial fishing mortality per fishing trip: a useful indicator of effective fishing effort in mixed demersal fisheries. ICES Journal of Marine Science. 63: 556-566.

van Oostenbrugge, H., Powell, J. P., Smit, J. P. G., Poos, J. J., Kraak, S. B. M., and Buisman, E. F. C. 2008. Linking catchability and fisher behaviour under effort management. Aquatic Living Resources, 21: 265-273.

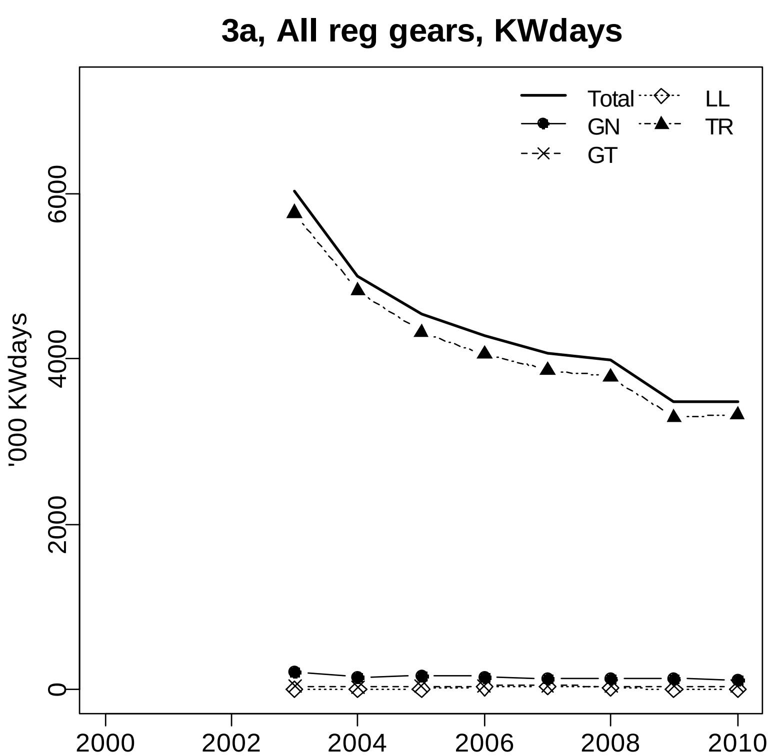
# Annex 7 Summary of Provisional Effort and Catch Information for cod stocks covered by Annex IIa – data compiled by STECF EWG -06 including 2010 data.

**(Note: No Spanish data; French data subject to significant revision)**

N. Bailey (Chair of EWG -06, STECF member) 20/6/2011

## 3a Kattegat

Effort trends - Regulated gears




Effort  Regulated and Unregulated gears

| REG GEAR COD | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GN1 | 305380 | 310351 | 361457 | 218651 | 143629 | 166703 | 157684 | 127651 | 130529 | 139371 | 118772 |
| GT1 | 43320 | 43989 | 42682 | 41481 | 26045 | 41054 | 44100 | 46289 | 41024 | 40727 | 40837 |
| LL1 | 1460 | 27477 | 60062 | 8923 | 4456 | 10684 | 27698 | 37856 | 25234 | 406 | |
| TR1 | 1042121 | 963870 | 643361 | 247080 | 209190 | 235705 | 204041 | 211900 | 218424 | 111081 | 82663 |
| TR2 | 5269301 | 5379334 | 4493063 | 4860676 | 4134540 | 3601254 | 3492836 | 3336687 | 3414865 | 3085533 | 3183319 |
| TR3 | 349804 | 511806 | 507228 | 654355 | 481725 | 485616 | 358274 | 307710 | 152411 | 97045 | 36383 |
| REG Total | 7011386 | 7236827 | 6107853 | 6031166 | 4999585 | 4541016 | 4284633 | 4068093 | 3982487 | 3474163 | 3461974 |

| UN REG GEAR | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DEM_SEINE | | | | 813 | | 354 | | | | | |
| DREDGE | 3782 | 11218 | 7881 | 7526 | 6461 | 33713 | 39802 | 50977 | 55259 | 36768 | 36517 |
| none | 12544 | 10384 | 28958 | 10309 | 15212 | 8924 | 17261 | 15766 | 24584 | 47342 | 41620 |
| OTTER | 283517 | 289388 | 284275 | 290906 | 205883 | 189643 | 258570 | 200213 | 157752 | 232709 | 75844 |
| PEL_SEINE | 2880 | 5240 | 22361 | 31059 | 20680 | 25640 | 52976 | 32560 | 16157 | 11000 | 19876 |
| PEL_TRAWL | 124187 | 312184 | 287663 | 395285 | 391770 | 448473 | 374703 | 349489 | 192363 | 378195 | 300799 |
| POTS | 53049 | 58700 | 52602 | 54894 | 85806 | 65450 | 75311 | 86516 | 75233 | 64289 | 29897 |
| UNREG Total | 479959 | 687114 | 683740 | 790792 | 725812 | 772197 | 818623 | 735521 | 521348 | 770303 | 504553 |
| TOTAL Effort | 7491345 | 7923941 | 6791593 | 6821958 | 5725397 | 5313213 | 5103256 | 4803614 | 4503835 | 4244466 | 3966527 |
| | | | | | | | | | | | |
| % UNREG | **6.406846835** | **8.671366937** | **10.06744662** | **11.59186263** | **12.67705977** | **14.53352237** | **16.04119017** | **15.31182564** | **11.57564609** | **18.14840783** | **12.72027141** |

Article 11 – <1.5% cod catch - effort

| | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|
| AREA | REG. GEA | MEMBER S | CPART 11 | Total effort | % Cpart 11 | CPART 11 | Total effort | % Cpart 11 |
| 3a | TR2 | SWE | 415194 | 851549 | 49% | 482432 | 767026 | 63% |
| 3a | TR2 | DEN | 0 | 2214066 | 0 | 0 | 2385563 | 0 |
| 3a | TR2 | GER | 0 | 19918 | 0 | 0 | 30730 | 0 |
| 3a | TR2 | ALL | 415194 | 3085533 | 13% | 482432 | 3183319 | 15% |
| 3a | All regulate | ALL | 415194 | 3474163 | 12% | 482432 | 3461974 | 14% |
| 3a | Total effort | ALL | 415194 | 4244466 | 10% | 482432 | 3966527 | 12% |

Article 13 – cod avoidance – effort

| | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|
| AREA | REG. GEA | MEMBER S | CPART 13 | Total effort | % Cpart 11 | CPART 13 | Total effort | % Cpart 11 |
| 3a | TR2 | DEN | 0 | 2214066 | 0% | 2385563 | 2385563 | 100% |
| 3a | TR2 | GER | 0 | 19918 | 0 | 20020 | 10710 | 0 |
| 3a | TR2 | other | 0 | 851549 | 0 | 0 | 767026 | 0 |
| 3a | TR2 | ALL | 0 | 3085533 | 0% | 2405583 | 3163299 | 76% |
| 3a | All regulate | ALL | 0 | 3474163 | 0% | 2405583 | 3461974 | 69% |
| 3a | Total effort | ALL | 0 | 4244466 | 0% | 2405583 | 3966527 | 61% |

Fully Documented fisheries (REM/CCTV) -effort

| | | |
|---|---|---|
| 3a | | |
| | | 2010 |
| Sweden | TR2 | 25294 |
| | | 25294 |
| | | 25294 |
| | | 25294 |

**3a Kattegat Catches**

| REG_GEAR | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| GN1 | | 87 | 36 | 26 | 25 | 28 | 45 | 13 | 10 |
| GT1 | | 21 | 14 | 7 | 3 | 4 | 3 | 1 | 1 |
| LL1 | | 20 | 2 | 1 | 3 | 0 | 14 | 0 | 0 |
| TR1 | | 257 | 188 | 174 | 58 | 130 | 36 | 29 | 4 |
| TR2 | | 2347 | 2026 | 1103 | 1293 | 853 | 466 | 210 | 201 |
| TR3 | | 79 | 26 | 14 | 36 | 7 | 7 | 0 | 0 |
| | Total REG | **2811** | **2292** | **1325** | **1418** | **1022** | **571** | **253** | **216** |

| REG_GEAR | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| DEM_SEINE | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| none | | 8 | 5 | 6 | 10 | 1 | 0 | 0 | 0 |
| OTTER | | 17 | 8 | 12 | 18 | 5 | 4 | 9 | 3 |
| PEL_TRAWL | | 2 | 3 | 5 | 15 | 4 | 0 | 0 | 0 |
| POTS | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total UNREG | 28 | 16 | 23 | 43 | 10 | 4 | 9 | 3 |
| | Total | **2839** | **2308** | **1348** | **1461** | **1032** | **575** | **262** | **219** |
| | % UNREG | 0.986263 | 0.693241 | 1.706231 | 2.94319 | 0.968992 | 0.695652 | 3.435115 | 1.369863 |

Article 11 - <1.5 cod catches – catch

| | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|
| AREA | REG. GEA | MEMBER | CPART 11 | Total catch | % Cpart 11 | CPART 11 | Total catch | % Cpart 11 |
| 3a | TR2 | SWE | 13 | 69 | 19% | 10 | 47 | 21% |
| 3a | TR2 | DEN | 0 | 140 | 0 | 0 | 153 | 0 |
| 3a | TR2 | GER | 0 | 0 | 0 | 0 | 0 | 0 |
| 3a | TR2 | ALL | 13 | 209 | 6% | 10 | 200 | 5% |
| 3a | All regulate | ALL | 13 | 253 | 5% | 10 | 216 | 5% |
| 3a | Total catch | ALL | 13 | 262 | 5% | 10 | 219 | 5% |

Article 13 – cod avoidance – catch

| | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|
| AREA | REG. GEA | MEMBER | CPART 13 | Total Catch | % Cpart 11 | CPART 13 | Total Catch | % Cpart 11 |
| 3a | TR2 | DEN | 0 | 140 | 0% | 153 | 153 | 100% |
| 3a | TR2 | GER | 0 | 0 | 0 | 0 | 0 | 0 |
| 3a | TR2 | other | 0 | 70 | 0 | 0 | 48 | 0 |
| 3a | TR2 | ALL | 0 | 210 | 0% | 153 | 201 | 76% |
| 3a | All regulate | ALL | 0 | 253 | 0% | 153 | 216 | 71% |
| 3a | Total Catch | ALL | 0 | 262 | 0% | 153 | 219 | 70% |

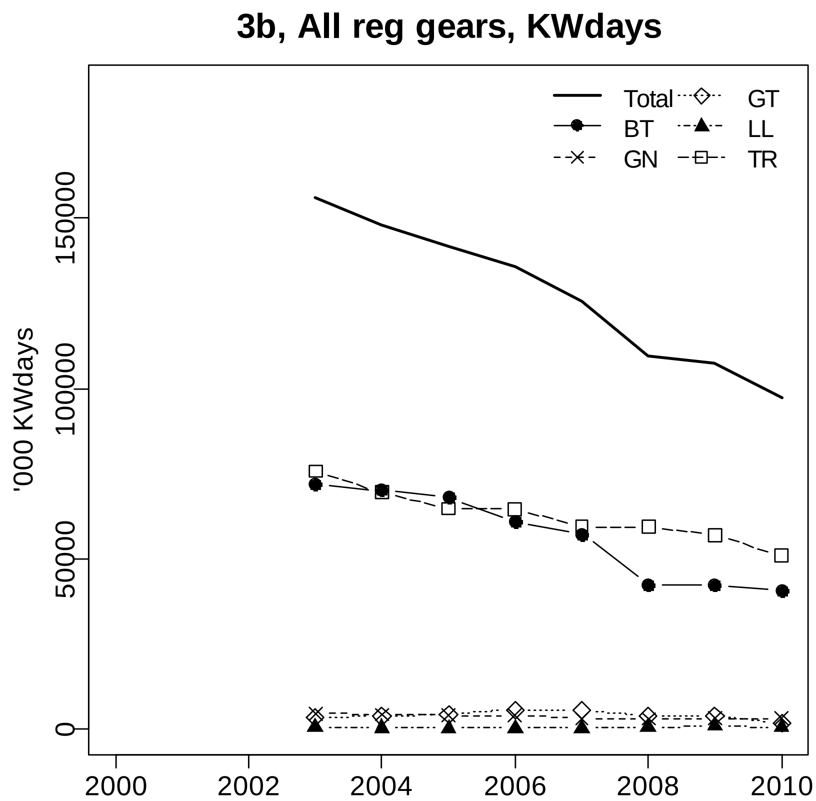
Fully Documented fisheries (REM/CCTV) catch

3a

| | | | | | | 2010 | |
|---|---|---|---|---|---|---|---|
| | | | | | | land | dis |
| FDFIIA | COD | 3a | TR2 | FDFIIA | SWE | 1 | 0 |

## 3b – North sea, Skagerrak, Eastern Channel

Effort trends Regulated gears




Effort Reg and Unreg gears

| REG GEAR COD | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BT1 | 2812567 | 2691963 | 7506993 | 6101145 | 5561566 | 5071363 | 5699183 | 3691347 | 2144592 | 1747555 | 1748302 |
| BT2 | 85075503 | 82401292 | 73803155 | 65659202 | 64487791 | 62943209 | 55359743 | 53652799 | 40346242 | 40653344 | 39099642 |
| GN1 | 6229125 | 6101511 | 7508773 | 4600849 | 4348091 | 4037958 | 4000344 | 3048211 | 3075301 | 3174941 | 3189811 |
| GT1 | 1094135 | 2198014 | 12557141 | 3553602 | 3699369 | 4404484 | 5727823 | 5506524 | 3868425 | 3924777 | 1812028 |
| LL1 | 835138 | 756416 | 2145689 | 510329 | 412305 | 367492 | 386193 | 400832 | 621740 | 922169 | 545530 |
| TR1 | 59600841 | 55206803 | 62494992 | 33136244 | 26488076 | 26511364 | 26927258 | 23822624 | 26026854 | 25883223 | 21479681 |
| TR2 | 19592842 | 25181885 | 70715739 | 39204264 | 39646161 | 35558023 | 35637126 | 34518968 | 32366844 | 30313249 | 25177764 |
| TR3 | 5570514 | 4008588 | 4220105 | 3421117 | 3370449 | 2743483 | 1966597 | 1020724 | 1016904 | 707469 | 1266010 |
| REG Total | **180810665** | **178546472** | **240952587** | **156186752** | **148013808** | **141637376** | **135704267** | **125662029** | **109466902** | **107326727** | **94318768** |

| UNREG GEAR COD | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BEAM | 12990183 | 13415705 | 13364169 | 13801328 | 13521284 | 13230382 | 12938958 | 13782031 | 13336844 | 14047370 | 12669242 |
| DEM_SEINE | 33037 | 18696 | 13393 | 26422 | 9718 | 23138 | 2585 | 13017 | 5214 | 14305 | 43871 |
| DREDGE | 2997329 | 2633554 | 3328222 | 4010953 | 4459314 | 5986424 | 3218067 | 3803033 | 3139961 | 3776311 | 4509999 |
| none | 126972 | 149974 | 172370 | 407572 | 385857 | 251012 | 308412 | 720239 | 773769 | 926110 | 200002 |
| OTTER | 15065463 | 16768090 | 14283394 | 14729542 | 14271608 | 9751513 | 9155423 | 6077251 | 8409456 | 9496032 | 9720585 |
| PEL_SEINE | 3041306 | 2388865 | 2239266 | 2531044 | 2721915 | 2720802 | 1998040 | 1417010 | 1153077 | 1432037 | 1134323 |
| PEL_TRAWL | 17845500 | 19292051 | 28531537 | 25213339 | 25336800 | 21606936 | 18926549 | 17389951 | 11399213 | 12252507 | 11134477 |
| POTS | 2745311 | 2868982 | 3492219 | 3160919 | 3127845 | 3242037 | 3523180 | 3610120 | 3500987 | 3589291 | 3536352 |
| UNREG Total | 54845101 | 57535917 | 65424570 | 63881119 | 63834341 | 56812244 | 50071214 | 46812652 | 41718521 | 45533963 | 42948851 |
| TOTAL Effort | **235655766** | **236082389** | **306377157** | **220067871** | **211848149** | **198449620** | **185775481** | **172474681** | **151185423** | **152860690** | **137267619** |
| | | | | | | | | | | | |
| % UNREG | 23.27339659 | 24.37111775 | 21.35425847 | 29.02791703 | 30.13212119 | 28.62804373 | 26.95254171 | 27.14175306 | 27.59427475 | 29.78788268 | 31.28840677 |

Article 11 – <1.5% cod catch - effort

| | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|
| REG AREA | REG GEAR | COUNTRY | Art 11 | total effort | % | Art 11 | total effort | % |
| 3b | TR2 | SCO | 0 | 8344074 | 0.0 | 97359 | 8302801 | 1.2 |
| 3b | TR2 | SWE | 766754 | 1547861 | 49.5 | 699160 | 1360491 | 51.4 |
| 3b | TR2 | Other | 0 | 20421314 | 0.0 | 0 | 15514472 | 0.0 |
| 3b | TR2 | ALL | 766754 | 30313249 | 2.5 | 796519 | 25177764 | 3.2 |
| 3b | All reg gear | All | 766754 | 1.07E+08 | 0.71 | 796519 | 94318768 | 0.84 |
| 3b | reg. + unre | All | 766754 | 1.53E+08 | 0.50 | 796519 | 1.37E+08 | 0.6 |

Article 13 – cod avoidance – effort

| | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|
| REG AREA | REG GEAR | COUNTRY | Art 13 | total effort | % | Art 13 | total effort | % |
| 3b | TR1 | ENG | 2145727 | 2145727 | 100.0 | 1685226 | 1685226 | 100.0 |
| 3b | TR1 | GER | 927872 | 1819825 | 51.0 | 918707 | 1831265 | 50.2 |
| 3b | TR1 | NIR | 56140 | 56140 | 100.0 | 29360 | 29360 | 100.0 |
| 3b | TR1 | SCO | 12245575 | 12245575 | 100.0 | 10444829 | 10444829 | 100.0 |
| 3b | TR1 | other | 0 | 9615956 | 0.0 | 0 | 7489001 | 0.0 |
| 3b | TR1 | ALL | 15375314 | 25883223 | 59.4 | 13078122 | 21479681 | 60.9 |
| 3b | All reg gear | All | 15375314 | 1.07E+08 | 14.33 | 13078122 | 94318768 | 13.87 |
| 3b | reg. + unre | All | 15375314 | 1.53E+08 | 10.06 | 13078122 | 1.37E+08 | 9.5 |
| 3b | TR2 | ENG | 1917712 | 1917712 | 100.0 | 1720026 | 1720026 | 100.0 |
| 3b | TR2 | GER | 2420 | 473834 | 0.5 | 39820 | 464345 | 8.6 |
| 3b | TR2 | NIR | 385631 | 385631 | 100.0 | 398498 | 398498 | 100.0 |
| 3b | TR2 | SCO | 8344074 | 8344074 | 100.0 | 8205442 | 8302801 | 98.8 |
| 3b | TR2 | Other | 0 | 19191998 | 0.0 | 0 | 14389453 | 0.0 |
| 3b | TR2 | ALL | 10649837 | 30313249 | 35.1 | 10363786 | 25275123 | 41.0 |
| 3b | All reg gear | All | 10649837 | 1.07E+08 | 9.92 | 10363786 | 94318768 | 10.99 |
| 3b | reg. + unre | All | 10649837 | 1.53E+08 | 6.97 | 10363786 | 1.37E+08 | 7.6 |

Fully Documented fisheries (REM/CCTV) effort

| 3b | | | | | | 2010 |
|---|---|---|---|---|---|---|
| ANNEX | REG AREA | REG GEAR | SPECON | COUNTRY | VESSEL_LENGTH | |
| FDFIIA | 3b | DREDGE | FDFIIA | ENG | o10t15m | 9847 |
| FDFIIA | 3b | GN1 | FDFIIA | ENG | o15m | 22101 |
| FDFIIA | 3b | none | FDFIIA | DEN | o15m | 3170 |
| FDFIIA | 3b | PEL_TRAW | FDFIIA | DEN | o15m | 2420 |
| FDFIIA | 3b | POTS | FDFIIA | DEN | o15m | 983 |
| FDFIIA | 3b | POTS | FDFIIA | ENG | o10t15m | 597 |
| FDFIIA | 3b | TR1 | FDFIIA | DEN | o15m | 1038901 |
| FDFIIA | 3b | TR1 | FDFIIA | ENG | o10t15m | 29840 |
| FDFIIA | 3b | TR1 | FDFIIA | ENG | o15m | 395493 |
| FDFIIA | 3b | TR1 | FDFIIA | SCO | O15M | 1531775 |
| FDFIIA | 3b | TR2 | FDFIIA | DEN | o15m | 10290 |
| FDFIIA | 3b | TR2 | FDFIIA | SCO | O15M | 81403 |

## 3b North Sea Catches

| REG_GEAR | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| BT1 | | 677 | 1183 | 1122 | 1336 | 688 | 549 | 230 | 323 |
| BT2 | | 3395 | 3842 | 2946 | 2691 | 2303 | 3560 | 2754 | 2128 |
| GN1 | | 3418 | 4040 | 3751 | 3228 | 2421 | 2519 | 2872 | 3385 |
| GT1 | | 499 | 340 | 343 | 344 | 346 | 373 | 470 | 472 |
| LL1 | | 211 | 127 | 133 | 228 | 183 | 207 | 127 | 288 |
| TR1 | | 13313 | 12471 | 14173 | 14792 | 17843 | 30461 | 25799 | 23780 |
| TR2 | | 7021 | 7339 | 6736 | 7832 | 11294 | 7510 | 8159 | 7599 |
| TR3 | | 51 | 28 | 31 | 30 | 4 | 57 | 2 | 17 |
| | Total REG | **28585** | **29370** | **29235** | **30481** | **35082** | **45236** | **40413** | **37992** |

| REG_GEAR | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| BEAM | | 39 | 24 | 20 | 14 | 24 | 32 | 113 | 51 |
| DEM_SEINE | | 1 | 0 | 3 | 3 | 1 | 0 | 2 | 10 |
| DREDGE | | 0 | 1 | 0 | 1 | 4 | 1 | 0 | 3 |
| none | | 30 | 30 | 12 | 23 | 10 | 44 | 63 | 27 |
| OTTER | | 391 | 328 | 3006 | 253 | 324 | 3974 | 207 | 282 |
| PEL_SEINE | | 0 | 0 | 12 | 1 | 0 | 0 | 0 | 3 |
| PEL_TRAWL | | 35 | 7 | 11 | 11 | 6 | 7 | 41 | 31 |
| POTS | | 14 | 16 | 17 | 15 | 11 | 7 | 7 | 12 |
| | Total UNREG | 510 | 406 | 3081 | 321 | 380 | 4065 | 433 | 419 |
| | Total | **29095** | **29776** | **32316** | **30802** | **35462** | **49301** | **40846** | **38411** |
| | % UNREG | 1.752879 | 1.363514 | 9.533977 | 1.04214 | 1.07157 | 8.245269 | 1.060079 | 1.090833 |

Article 11 - <1.5 cod catches – catch

| | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|
| REG AREA | REG GEAR | COUNTRY | Art 11 | total catch | % | Art 11 | total catch | % |
| 3b | TR2 | SCO | 0 | 1261 | 0.0 | 69 | 1465 | 4.7 |
| 3b | TR2 | SWE | 4 | 539 | 0.7 | 14 | 349 | 4.0 |
| 3b | TR2 | Other | 0 | 6358 | 0.0 | 0 | 5795 | 0.0 |
| 3b | TR2 | ALL | 4 | 8158 | 0.0 | 83 | 7609 | 1.1 |
| 3b | All reg gea | All | 4 | 40413 | 0.01 | 83 | 37992 | 0.22 |
| 3b | reg. + unre | All | 4 | 40846 | 0.01 | 83 | 38411 | 0.2 |

Article 13 – cod avoidance – catch

| | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|
| REG AREA | REG GEAR | COUNTRY | Art 13 | total Catch | % | Art 13 | total Catch | % |
| 3b | TR1 | ENG | 1250 | 1250 | 100.0 | 1211 | 1211 | 100.0 |
| 3b | TR1 | GER | 147 | 2468 | 6.0 | 156 | 2787 | 5.6 |
| 3b | TR1 | NIR | 6 | 6 | 100.0 | 2 | 2 | 100.0 |
| 3b | TR1 | SCO | 14622 | 14622 | 100.0 | 14065 | 14065 | 100.0 |
| 3b | TR1 | other | 0 | 7453 | 0.0 | 0 | 5715 | 0.0 |
| 3b | TR1 | ALL | 16025 | 25799 | 62.1 | 15434 | 23780 | 64.9 |
| 3b | All reg gea | All | 16025 | 40413 | 39.65 | 15434 | 37992 | 40.62 |
| 3b | reg. + unre | All | 16025 | 40846 | 39.23 | 15434 | 38411 | 40.2 |
| 3b | TR2 | ENG | 464 | 464 | 100.0 | 375 | 464 | 80.8 |
| 3b | TR2 | GER | 1 | 187 | 0.5 | 23 | 199 | 11.6 |
| 3b | TR2 | NIR | 123 | 123 | 100.0 | 59 | 59 | 100.0 |
| 3b | TR2 | SCO | 1261 | 1261 | 100.0 | 1396 | 1465 | 95.3 |
| 3b | TR2 | Other | 0 | 6124 | 0.0 | 0 | 5412 | 0.0 |
| 3b | TR2 | ALL | 1849 | 8159 | 22.7 | 1853 | 7599 | 24.4 |
| 3b | All reg gea | All | 1849 | 40413 | 4.58 | 1853 | 37922 | 4.89 |
| 3b | reg. + unre | All | 1849 | 40846 | 4.53 | 1853 | 38411 | 4.8 |

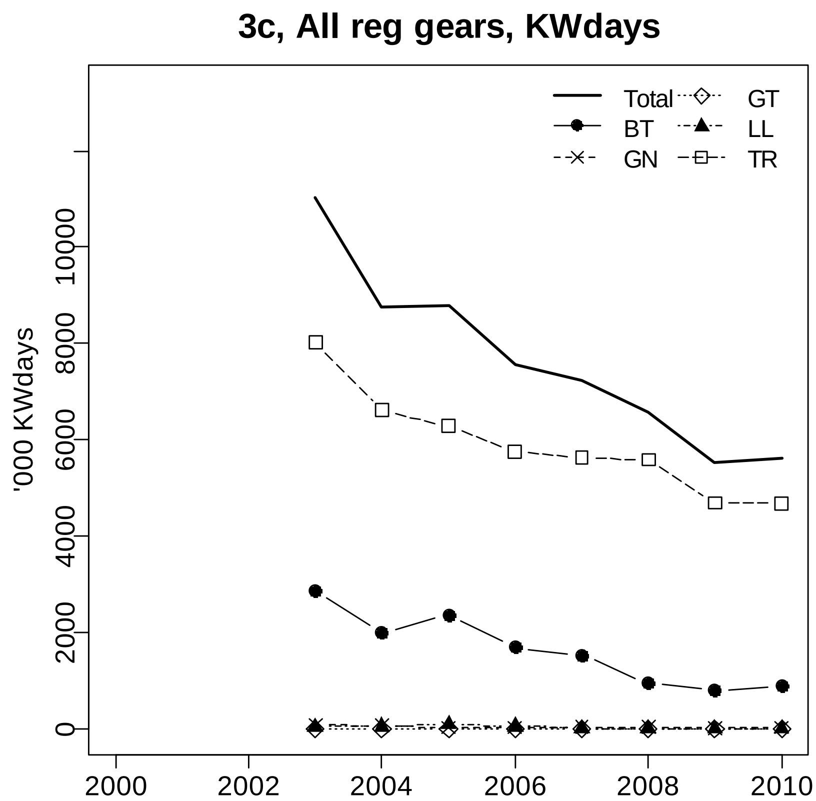
Fully Documented fisheries (REM/CCTV) catch

3b

| | | | | | | 2010 land | dis |
|---|---|---|---|---|---|---|---|
| FDFIIA | COD | 3b | DREDGE | FDFIIA | ENG | 0 | 0 |
| FDFIIA | COD | 3b | GN1 | FDFIIA | ENG | 132 | 0 |
| FDFIIA | COD | 3b | POTS | FDFIIA | ENG | 5 | 0 |
| FDFIIA | COD | 3b | TR1 | FDFIIA | DEN | 969 | 15 |
| FDFIIA | COD | 3b | TR1 | FDFIIA | ENG | 286 | 47 |
| FDFIIA | COD | 3b | TR1 | FDFIIA | SCO | 2330 | 0 |
| FDFIIA | COD | 3b | TR2 | FDFIIA | SCO | 16 | 0 |

## 3c Irish Sea

Effort trends Regulated gears




Effort Reg and Unreg gears

| REG GEAR COD | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BT2 | 1617383 | 2007800 | 2219020 | 2881456 | 2005022 | 2377308 | 1694550 | 1539672 | 948062 | 804724 | 896069 |
| GN1 | 35104 | 43564 | 74239 | 91485 | 73097 | 38416 | 38070 | 49011 | 45254 | 25036 | 34948 |
| GT1 | 523 | | | | | | 475 | 656 | 2393 | 4025 | 1852 |
| LL1 | 180243 | 185365 | 87888 | 47385 | 59214 | 93773 | 59656 | 12238 | 989 | 924 | 2588 |
| TR1 | 1846600 | 2393214 | 3643561 | 3178548 | 1693343 | 1238516 | 1051113 | 565610 | 610126 | 486769 | 478044 |
| TR2 | 4438444 | 4273573 | 3216575 | 4836818 | 4921676 | 5045026 | 4705062 | 5076416 | 4979739 | 4205977 | 4211499 |
| TR3 | | | | 2026 | 90 | 3305 | 960 | | 436 | | |
| REG Total | **8118297** | **8903516** | **9241283** | **11037718** | **8752442** | **8796344** | **7549886** | **7243603** | **6586999** | **5527455** | **5625000** |

| UN REG GEAR COD | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BEAM | 805950 | 669403 | 780129 | 31213 | 160981 | 25324 | 8221 | 8992 | 29989 | 9494 | 1788 |
| DEM_SEINE | 23180 | 27798 | 26993 | | 759 | | 142 | | | | |
| DREDGE | 1461545 | 1632052 | 1491559 | 1630092 | 1406478 | 1260910 | 1143714 | 1504464 | 1939512 | 1845719 | 1748553 |
| none | | 709 | | | | 2130 | | 906 | 96 | | |
| OTTER | 1992397 | 1775119 | 1772299 | 31726 | 100937 | 5704 | 8488 | 820 | | 1025 | 8708 |
| PEL_SEINE | 20940 | 22729 | 29223 | 47712 | 27914 | 61552 | 34310 | | 1131 | | |
| PEL_TRAWL | 166450 | 245782 | 112977 | 148994 | 220213 | 211827 | 151959 | 165394 | 118398 | 97653 | 206296 |
| POTS | 280985 | 300102 | 412446 | 582307 | 531491 | 531084 | 590775 | 643381 | 640229 | 751292 | 982215 |
| UNREG Total | 4751447 | 4673694 | 4625626 | 2472044 | 2448773 | 2098531 | 1937609 | 2323957 | 2729355 | 2705183 | 2947560 |
| TOTAL Effort | **12869744** | **13577210** | **13866909** | **13509762** | **11201215** | **10894875** | **9487495** | **9567560** | **9316354** | **8232638** | **8572560** |
| | | | | | | | | | | | |
| % UNREG | 36.91951448 | 34.42308103 | 33.35729686 | 18.2982054 | 21.86167304 | 19.26163448 | 20.42276702 | 24.28996526 | 29.29638569 | 32.85924876 | 34.38366136 |

Article 11 – <1.5% cod catch - effort

| | | | 2009 | 2009 | 2009 | 2010 | 2010 | 2010 |
|---|---|---|---|---|---|---|---|---|
| AREA | GEAR | COUNTRY | CPART11 | ALL-SPEC | % CPART1 | CPART11 | ALL-SPEC | % CPART1 |
| 3c | TR1 | ENG | 0 | 21860 | 0% | 0 | 25111 | 0% |
| 3c | TR1 | FRA | 0 | 15241 | 0% | 0 | 5418 | 0% |
| 3c | TR1 | IOM | 0 | 0 | | 0 | 0 | |
| 3c | TR1 | IRL | 0 | 60348 | 0% | 0 | 95243 | 0% |
| 3c | TR1 | NED | 0 | 0 | | 0 | 0 | |
| 3c | TR1 | NIR | 0 | 384860 | 0% | 0 | 350609 | 0% |
| 3c | TR1 | SCO | 0 | 0 | | 0 | 1663 | 0% |
| 3c | TR1 all nat | ALL | 0 | 482309 | 0% | 0 | 478044 | 0% |
| 3c | All regulate | ALL | 0 | 5522995 | 0% | 0 | 5625000 | 0% |
| 3c | Total effort | ALL | 0 | 8228178 | 0% | 0 | 8572560 | 0% |
| 3c | TR2 | BEL | 0 | 29980 | 0% | 0 | 14283 | 0% |
| 3c | TR2 | ENG | 0 | 171656 | 0% | 0 | 180844 | 0% |
| 3c | TR2 | FRA | 0 | 0 | | 0 | 803 | 0% |
| 3c | TR2 | GBJ | 0 | 0 | | 0 | 0 | |
| 3c | TR2 | IOM | 0 | 23022 | 0% | 0 | 23928 | 0% |
| 3c | TR2 | IRL | 0 | 853159 | 0% | 156988 | 1187022 | 13% |
| 3c | TR2 | NIR | 0 | 3097345 | 0% | 0 | 2777583 | 0% |
| 3c | TR2 | SCO | 0 | 30815 | 0% | 9055 | 27036 | 33% |
| 3c | TR2 all nat | ALL | 0 | 4205977 | 0% | 166043 | 4211499 | 4% |
| 3c | All regulate | ALL | 0 | 5522995 | 0% | 166043 | 5625000 | 3% |
| 3c | Total effort | ALL | 0 | 8228178 | 0% | 166043 | 8572560 | 2% |

Article 13 – cod avoidance – effort

| | | | 2009 | 2009 | 2009 | 2010 | 2010 | 2010 |
|---|---|---|---|---|---|---|---|---|
| AREA | GEAR | COUNTRY | CPART13 | ALL-SPEC | % CPART1 | CPART13 | ALL-SPEC | % CPART1 |
| 3c | TR1 | ENG | 21860 | 21860 | 100% | 25111 | 25111 | 100% |
| 3c | TR1 | NIR | 384860 | 384860 | 100% | 350609 | 350609 | 100% |
| 3c | TR1 | SCO | 0 | 0 | | 1663 | 1663 | 100% |
| 3c | TR1 | other | 0 | 80049 | 0% | 0 | 100661 | 0% |
| 3c | TR1 all nat | ALL | 406720 | 486769 | 84% | 377383 | 478044 | 79% |
| 3c | All regulate | ALL | 406720 | 5522995 | 7% | 377383 | 5625000 | 7% |
| 3c | Total effort | ALL | 406720 | 8228178 | 5% | 377383 | 8572560 | 4% |
| 3c | TR2 | ENG | 194678 | 194678 | 100% | 204772 | 204772 | 100% |
| 3c | TR2 | IRL | 35827 | 853159 | 4% | 163894 | 1187022 | 14% |
| 3c | TR2 | NIR | 3097345 | 3097345 | 100% | 2777583 | 2777583 | 100% |
| 3c | TR2 | SCO | 30815 | 30815 | 100% | 17981 | 17981 | 100% |
| 3c | TR2 | other | 0 | 29980 | 0% | 0 | 24141 | 0% |
| 3c | TR2 all nat | ALL | 3358665 | 4205977 | 80% | 3164230 | 4211499 | 75% |
| 3c | All regulate | ALL | 3358665 | 5522995 | 61% | 3164230 | 5625000 | 56% |
| 3c | Total effort | ALL | 3358665 | 8228178 | 41% | 3164230 | 8572560 | 37% |

## 3c Irish Sea Catches

| REG_GEAR | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| BT2 | | 248 | 125 | 156 | 78 | 127 | 32 | 29 | 70 |
| GN1 | | 93 | 117 | 55 | 131 | 329 | 392 | 78 | 78 |
| GT1 | | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| LL1 | | 1 | 1 | 2 | 3 | 1 | 12 | 0 | 0 |
| TR1 | | 567 | 445 | 374 | 415 | 339 | 468 | 363 | 241 |
| TR2 | | 416 | 686 | 553 | 376 | 551 | 351 | 184 | 478 |
| | REG Total | **1325** | **1374** | **1140** | **1003** | **1348** | **1256** | **655** | **869** |

| REG_GEAR | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| BEAM | | 1 | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| DREDGE | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTTER | | 5 | 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| PEL_SEINE | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| PEL_TRAWL | | 4 | 5 | 0 | 1 | 3 | 0 | 1 | 1 |
| POTS | | 1 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| | UNREG Tc | 12 | 52 | 0 | 1 | 3 | 0 | 1 | 1 |
| | Total | **1337** | **1426** | **1140** | **1004** | **1351** | **1256** | **656** | **870** |
| | | | | | | | | | |
| | % | 0.897532 | 3.646564 | 0 | 0.099602 | 0.222058 | 0 | 0.152439 | 0.114943 |

Article 11 - <1.5 cod catches – catch

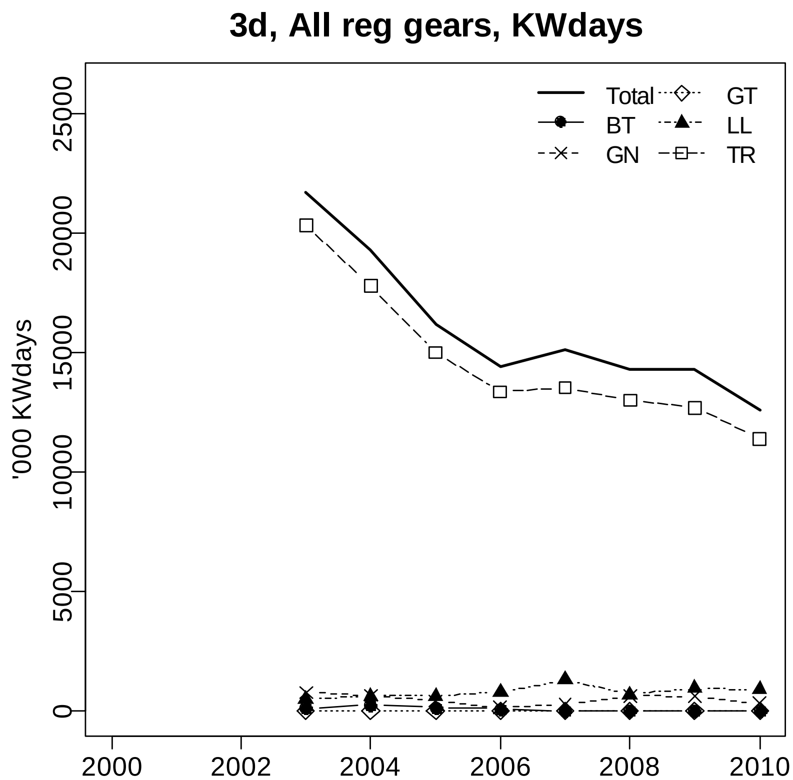
| | | | 2009 | 2009 | 2009 | 2010 | 2010 | 2010 |
|---|---|---|---|---|---|---|---|---|
| AREA | GEAR | COUNTRY | CPART11 | ALL-SPEC | % CPART1 | CPART11 | ALL-SPEC | % CPART1 |
| 3c | TR2 | SCO | 0 | 1 | 0% | 0 | 1 | 0% |
| 3c | TR2 | other | 0 | 183 | | 0 | 477 | |
| 3c | TR2 all nat | ALL | 0 | 184 | 0% | 0 | 478 | 0% |
| 3c | All regulate | ALL | 0 | 655 | 0% | 0 | 869 | 0% |
| 3c | Total catch | ALL | 0 | 656 | 0% | 0 | 870 | 0% |

Article 13 – cod avoidance – catch

| | | | 2009 | 2009 | 2009 | 2010 | 2010 | 2010 |
|---|---|---|---|---|---|---|---|---|
| AREA | GEAR | COUNTRY | CPART13 | ALL-SPEC | % CPART1 | CPART13 | ALL-SPEC | % CPART1 |
| 3c | TR1 | ENG | 4 | 4 | 100% | 9 | 9 | 100% |
| 3c | TR1 | NIR | 286 | 286 | 100% | 190 | 190 | 100% |
| 3c | TR1 | SCO | 0 | 0 | 0% | 0 | 0 | #DIV/0! |
| 3c | TR1 | other | 0 | 73 | 0% | 0 | 42 | 0% |
| 3c | TR1 all nat | ALL | 290 | 363 | 80% | 199 | 241 | 83% |
| 3c | All regulate | ALL | 290 | 655 | 44% | 199 | 869 | 23% |
| 3c | Total Catch | ALL | 290 | 656 | 44% | 199 | 870 | 23% |
| 3c | TR2 | ENG | 1 | 1 | 100% | 6 | 6 | 100% |
| 3c | TR2 | IRL | 0 | 81 | 0% | 0 | 136 | 0% |
| 3c | TR2 | NIR | 94 | 94 | 100% | 327 | 327 | 100% |
| 3c | TR2 | SCO | 1 | 1 | 100% | 1 | 1 | 100% |
| 3c | TR2 | other | 0 | 7 | 0% | 0 | 8 | 0% |
| 3c | TR2 all nat | ALL | 96 | 184 | 52% | 334 | 478 | 70% |
| 3c | All regulate | ALL | 96 | 655 | 15% | 334 | 869 | 38% |
| 3c | Total Catch | ALL | 96 | 656 | 15% | 334 | 870 | 38% |

## 3d West Scotland

Effort trends Regulated gears




Effort  Reg and Unreg gears

| REG GEAR COD | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BT1 | 4894 | | | 61815 | 166807 | 119958 | 81195 | 1803 | | | |
| BT2 | 129252 | 98005 | 110353 | 46106 | 93215 | 15444 | 10750 | 2356 | | | |
| GN1 | 516683 | 633621 | 1190156 | 782170 | 646402 | 412405 | 156970 | 280344 | 629427 | 618620 | 332492 |
| GT1 | 2829 | 157448 | | 636 | 435 | 5410 | 448 | | | | |
| LL1 | 806642 | 804192 | 741513 | 502828 | 626671 | 628949 | 819031 | 1299306 | 684589 | 981146 | 897903 |
| TR1 | 16036535 | 17437389 | 36489544 | 12906880 | 10947581 | 9190944 | 7723086 | 7641364 | 6970660 | 7335020 | 6571087 |
| TR2 | 5432593 | 5280734 | 5254005 | 7230404 | 6735807 | 5761558 | 5613455 | 5895213 | 6011367 | 5356787 | 4688657 |
| TR3 | 61109 | 51340 | 132184 | 188903 | 98285 | 41544 | 11680 | 573 | 11321 | 1323 | |
| REG Total | **22990537** | **24462729** | **43917755** | **21719742** | **19315203** | **16176212** | **14416615** | **15120959** | **14307364** | **14292896** | **12490139** |

| UNREG GEAR COD | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BEAM | 10523 | 12528 | | | 10136 | | | | | | |
| DEM_SEINE | 75298 | 24711 | 31916 | 644 | | | | | | | |
| DREDGE | 1981727 | 2037696 | 2245875 | 1956374 | 1684266 | 1510557 | 1161672 | 911530 | 1075527 | 1071327 | 1002770 |
| none | 50876 | 57096 | 59694 | 52102 | 26858 | 42249 | 50920 | 63504 | 68847 | 99379 | 100269 |
| OTTER | 2016559 | 1818225 | 1492506 | 188543 | 514781 | 654988 | 290705 | 41340 | 151384 | 171586 | 98570 |
| PEL_SEINE | 609134 | 492967 | 358793 | 249004 | 266254 | 157776 | 186486 | 113645 | | | 53255 |
| PEL_TRAWL | 9624812 | 10610905 | 12429002 | 11623490 | 17006375 | 13187476 | 11060133 | 9890496 | 8636882 | 7488991 | 5721420 |
| POTS | 2188417 | 2546277 | 2497117 | 2637737 | 2664107 | 2762361 | 2725839 | 3429787 | 2906422 | 2884610 | 3482270 |
| UNREG Total | 16557346 | 17600405 | 19114903 | 16707894 | 22172777 | 18315407 | 15475755 | 14450302 | 12839062 | 11715893 | 10458554 |
| TOTAL Effort | **39547883** | **42063134** | **63032658** | **38427636** | **41487980** | **34491619** | **29892370** | **29571261** | **27146426** | **26008789** | **22948693** |
| | | | | | | | | | | | |
| % UNREG | 41.86657981 | 41.84282845 | 30.32539577 | 43.47884944 | 53.44385771 | 53.10103594 | 51.7715892 | 48.86603246 | 47.29558875 | 45.04589968 | 45.57363681 |

Article 11 – <1.5% cod catch - effort

| | | | 2009 | 2009 | 2009 | 2010 | 2010 | 2010 |
|---|---|---|---|---|---|---|---|---|
| AREA | GEAR | COUNTRY | CPART11 | ALL-SPEC | % CPART1 | CPART11 | ALL-SPEC | % CPART1 |
| 3d | TR1 | ENG | 0 | 24446 | 0% | 0 | 14062 | 0% |
| 3d | TR1 | FRA | 0 | 4147092 | 0% | 0 | 3352214 | 0% |
| 3d | TR1 | GER | 0 | 4854 | 0% | 0 | 6957 | 0% |
| 3d | TR1 | IOM | 0 | 0 | | 0 | 0 | |
| 3d | TR1 | IRL | 0 | 549300 | 0% | 0 | 813886 | 0% |
| 3d | TR1 | NIR | 0 | 45378 | 0% | 0 | 23860 | 0% |
| 3d | TR1 | SCO | 0 | 2228713 | 0% | 44284 | 2360108 | 2% |
| 3d | TR1 all nat | ALL | 0 | 6999783 | 0% | 44284 | 6571087 | 1% |
| 3d | All regulate | ALL | 0 | 13957659 | 0% | 44284 | 12490139 | 0% |
| 3d | Total effort | ALL | 0 | 25673552 | 0% | 44284 | 22948693 | 0% |
| 3d | TR2 | BEL | 0 | 0 | | 0 | 1176 | 0% |
| 3d | TR2 | ENG | 0 | 15721 | 0% | 0 | 14802 | 0% |
| 3d | TR2 | FRA | 0 | 274203 | 0% | 0 | 0 | |
| 3d | TR2 | IOM | 0 | 0 | | 0 | 0 | |
| 3d | TR2 | IRL | 0 | 17989 | 0% | 0 | 11876 | 0% |
| 3d | TR2 | NIR | 0 | 523976 | 0% | 0 | 874396 | 0% |
| 3d | TR2 | SCO | 0 | 4524898 | 0% | 1054957 | 3786407 | 28% |
| 3d | TR2 all nat | ALL | 0 | 5356787 | 0% | 1054957 | 4688657 | 23% |
| 3d | All regulate | ALL | 0 | 13957659 | 0% | 1054957 | 12490139 | 8% |
| 3d | Total effort | ALL | 0 | 25673552 | 0% | 1054957 | 22948693 | 5% |

Article 13 – cod avoidance – effort

| | | | 2009 | 2009 | 2009 | 2010 | 2010 | 2010 |
|---|---|---|---|---|---|---|---|---|
| AREA | GEAR | COUNTRY | CPART13 | ALL-SPEC | % CPART1 | CPART13 | ALL-SPEC | % CPART1 |
| 3d | TR1 | GER | | 4854 | 0% | 4530 | 6957 | 65% |
| 3d | TR1 | IRL | 549300 | 549300 | 100% | 813886 | 813886 | 100% |
| 3d | TR1 | SCO | 2228713 | 2228713 | 100% | 2315824 | 2315824 | 100% |
| 3d | TR1 | other | 0 | 4552153 | 0% | 0 | 3434420 | 0% |
| 3d | TR1 all nat | ALL | 2778013 | 7335020 | 38% | 3134240 | 6571087 | 48% |
| 3d | All regulate | ALL | 2778013 | 13957659 | 20% | 3134240 | 12490139 | 25% |
| 3d | Total effort | ALL | 2778013 | 25673552 | 11% | 3134240 | 22948693 | 14% |
| 3d | TR2 | SCO | 4524898 | 4524898 | 100% | 2731450 | 3786407 | 72% |
| 3d | TR2 | other | 0 | 831889 | 0% | 0 | 902250 | 0% |
| 3d | TR2 all nat | ALL | 4524898 | 5356787 | 84% | 2731450 | 4688657 | 58% |
| 3d | All regulate | ALL | 4524898 | 13957659 | 32% | 2731450 | 12490139 | 22% |
| 3d | Total effort | ALL | 4524898 | 25673552 | 18% | 2731450 | 22948693 | 12% |

Fully Documented fisheries (REM/CCTV) effort

3d

| ANNEX | REG AREA | REG GEAR | SPECON | COUNTRY | VESSEL_LENGTH | 2010 |
|---|---|---|---|---|---|---|
| FDFIIA | 3d | TR1 | FDFIIA | SCO | O15M | 126775 |

## 3d West Scotland Catches

| REG_GEAR | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| BT1 | 2 | 6 | 1 | 0 | 0 | 0 | 0 | 0 |
| BT2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GN1 | 6 | 1 | 6 | 9 | 14 | 10 | 6 | 2 |
| LL1 | 8 | 5 | 5 | 14 | 8 | 0 | 0 | 0 |
| TR1 | 995 | 493 | 451 | 764 | 1191 | 1400 | 923 | 1226 |
| TR2 | 337 | 176 | 86 | 264 | 508 | 58 | 58 | 23 |
| **REG Total** | **1348** | **681** | **549** | **1051** | **1721** | **1468** | **987** | **1251** |

| REG_GEAR | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| DEM_SEINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DREDGE | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| none | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTTER | 1 | 1 | 0 | 10 | 0 | 0 | 0 | 0 |
| PEL_SEINE | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PEL_TRAWL | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| POTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNREG Total | 6 | 2 | 1 | 10 | 1 | 1 | 0 | 1 |
| **Total** | **1354** | **683** | **550** | **1061** | **1722** | **1469** | **987** | **1252** |
| % | 0.443131 | 0.292826 | 0.181818 | 0.942507 | 0.058072 | 0.068074 | 0 | 0.079872 |

Article 11 - <1.5 cod catches – catch

| | | | 2009 | 2009 | 2009 | 2010 | 2010 | 2010 |
|---|---|---|---|---|---|---|---|---|
| AREA | GEAR | COUNTRY | CPART11 | ALL-SPEC | % CPART1 | CPART11 | ALL-SPEC | % CPART1 |
| 3d | TR2 | SCO | 0 | 54 | 0% | 17 | 22 | 77% |
| 3d | TR2 | other | 0 | 3 | 0% | 0 | 1 | 0% |
| 3d | TR2 all nat | ALL | 0 | 57 | 0% | 17 | 23 | 74% |
| 3d | All regulate | ALL | 0 | 987 | 0% | 17 | 1251 | 1% |
| 3d | Total catch | ALL | 0 | 987 | 0% | 17 | 1252 | 1% |

Article 13 – cod avoidance – catch

| | | | 2009 | 2009 | 2009 | 2010 | 2010 | 2010 |
|---|---|---|---|---|---|---|---|---|
| AREA | GEAR | COUNTRY | CPART13 | ALL-SPEC | % CPART1 | CPART13 | ALL-SPEC | % CPART1 |
| 3d | TR1 | GER | 0 | 0 | 0% | 0 | 0 | 0% |
| 3d | TR1 | IRL | 121 | 122 | 99% | 201 | 201 | 100% |
| 3d | TR1 | SCO | 706 | 706 | 100% | 573 | 573 | 100% |
| 3d | TR1 | other | 0 | 95 | 0% | 0 | 452 | 0% |
| 3d | TR1 all nat | ALL | 827 | 923 | 90% | 774 | 1226 | 63% |
| 3d | All regulate | ALL | 827 | 987 | 84% | 774 | 1251 | 62% |
| 3d | Total Catch | ALL | 827 | 987 | 84% | 774 | 1252 | 62% |
| 3d | TR2 | SCO | 54 | 54 | 100% | 5 | 22 | 23% |
| 3d | TR2 | other | 0 | 4 | 0% | 0 | 1 | 0% |
| 3d | TR2 all nat | ALL | 54 | 58 | 93% | 5 | 23 | 22% |
| 3d | All regulate | ALL | 54 | 987 | 5% | 5 | 1251 | 0% |
| 3d | Total Catch | ALL | 54 | 987 | 5% | 5 | 1252 | 0% |

Fully Documented fisheries (REM/CCTV) catch

3d

| | | | | | | 2010 land | 2010 dis |
|---|---|---|---|---|---|---|---|
| FDFIIA | COD | 3d | TR1 | FDFIIA | SCO | 11 | 0 |

# Annex 8 Fishing mortality of cod in the Kattegat 2007–2010, estimated from spatial and temporal overlap of stock distribution and effort data.

by

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## Summary

Statistical spatial/temporal analysis of survey catches of cod shows that the distribution of young and older cod is very different and that the distribution change by season. Older cod is mainly found in the deeper part of the eastern and southern Kattegat, while the distribution of younger cod is more disperse, but with the highest concentrations in the north western Kattegat.

For quarter 1, the predicted stock distribution is a rather dispersed for the 1 group cod with the highest concentration in the North-western Kattegat. Age 2 is mainly concentrated in the deeper eastern Kattegat while age 3 plus, which includes the most of the spawning stock at spawning time, is concentrated in the area closed for all fisheries in the Southern Kattegat. Stock abundance for age 1, age 2 and 3plus show a clear downward trend for whole time series 1996-2011, but has increased significantly since 2009 for all ages.

The upward trend in abundance of Age 2 and older is confirmed by the analysis using data from quarter 3. Age 2 plus cod is manly concentrated in the north-eastern Kattegat, with part of the high concentration area within the closed area, where selective gears are mandatory.

For quarter 4, age 1 abundance in 2010 is lower than in 2009, but higher than in 2008. For age 2 the abundance has increased since 2008, but the opposite is the case for age 3+. The predicted concentrations of age 0 and 1 are highest in the north-western Kattegat. Age 2 and older is distributed more southerly with high concentrations in the closed area, where selective gears are mandatory.

Analyses of the centre of gravity of cod survey catches for the winter period, quarter 1 and 4, do not show a consistent change in stock distribution for the last 20 years. The situation seems however different for the summer period, where a more northerly centre of gravity of cod catches in quarter 3 IBTS indicates a more northerly distribution for all ages of cod in recent years.

The introduction of closed Kattegat areas in 2009 had, as intended, given a very low effort in the affected areas in the first quarter of 2009 and 2010. Total annual effort

(VMS records) seems however to have been stable (2009) or increased (2010) since the closure. For both years, effort was reallocated outside the closed areas, mainly to the more westerly grounds. The second quarter of 2009 had a very low effort in the area where fishery is allowed, 1st April to 31th December with gears with low catch of cod (Swedish grid or SELTRA 300). This pattern changed significantly in 2010 where this area had the highest concentration of effort in the time series (2007-2010). The reason for this change is not investigated further, but it might be linked to a higher CPUE of especially larger Nephrops in the area due to the area closure the year before. The change in effort distribution for quarter 3, with an increase of effort in the area with mandatory use of selective gears, seems similar to the changes observed for quarter 2. The decrease in effort in the first year of closure was however not that pronounced as for the second quarter, which indicates fast adaptation from the industry to the closures. Total effort (VMS records) in quarter 4 has decreased substantially since 2007.

The closure of the northern Sound ("Kilen") has almost entirely removed effort by segment TR1 and TR2 in that area.

Based on VMS data and predicted stock distribution, the fishing impact (proxy for Fishing mortality) on cod in Kattegat from the TR2 segment has decreased in the period 2007-2010 for all ages. The fishing impact in 2010 is estimated to be around 63% of the impact in 2007, which is equivalent to an annual decrease of around 14%. Nominal effort measured as kW-days has remained at the same level since 2007, so the decrease is due to a combination of closed areas which exclude the fishery from areas of high cod densities, and the application of selective gears. The reduction in fishing impact was highest in 2009 due to the introduction of closed areas. In 2010, effort increased again these areas due to the application of mandatory selective gears, required for access to the areas. This resulted in an overall decrease in fishing impact in 2010, however smaller than estimated for 2009.

## Background

The very low cod TAC and even lower reported landings in the most recent years have led to a very uncertain ICES stock assessment with respect to the estimate of fishing mortality (F). Consequently, the assessment cannot be used as basis for evaluating the most recent F in relation to any F reference point given by the management plan.

Several management measures have been applied to decrease F on cod, and to maintain the present level of fishing effort for the economical important fisheries targeting *Nephrops* and sole. The most important measures are probably the introduction of closed areas and application of trawl with sorting grid or SELTRA 300:

1) Closed areas for protection of cod were established in 2009 in Kattegat (see Figure 1):

    a) Area 1 (the "black" area) is closed 1st January- 31th March (cod spawning season), except for fishery with selective gears with a very low catch of cod. In area 1 the Northern Sound is closed 1st February -31th March, except for fishery with selective gears. This area is named "Kilen" (the Triangle) ;

    b) Area 2 (the "orange" area) is closed for bottom trawling 1st January- 31th March and all year for all fisheries except fisheries with selective gears with a low catch of cod, e.g. sorting grid;

    c) Area 3 (the "red" area) is closed for all fisheries, including recreational fisheries.

2) Application of selective gears:
   a) Application of the "Swedish sorting grid" is approved as special condition, which exempt the vessel from the kW-days regulation and gives access to the closed areas where selective gears are mandatory.
   b) Application of trawl and seine equipped with SELTRA 300 gives access to the closed areas in the period where selective gears are mandatory.

Other initiatives to reduce discards have also been introduced, not all of them will be mentioned here. In Danish fisheries, the usage of the exit-window with square-meshes at a minimum 120 mm has been mandatory since 1st February 2008. However, according to STECF (REFERENCE to the most recent STECF Plenary) the effect of the 120 mm square –mesh panel is not significant and its effect is not considered further in this document.

It is not possible to quantify the effects of all the management measures one by one. In this paper we disregard landings and discard information, but investigate changes in fishing effort from VMS data and gear information. Effects of gear changes and the associated change in catchability of cod are included to quantify the spatial and temporal distribution of cod specific fishing pressure. The fishing impact (proxy for fishing mortality) on cod is estimated by overlaying the spatial and temporal distribution of pressure (VMS data and gear catchability) and a predicted stock distribution.

## Method

The fishing impact on the cod population in the period 2007-2010 is analysed from the temporal and spatial distribution of the cod stock and the fishery, as outlined below:

1. Map the stock distribution of cod in Kattegat
   a. Use surveys to model cod density by quarter as a function of catch position (longitude, latitude), depth, year and survey
   b. Predict the distribution of the cod stock in Kattegat from the fitted model and a bathymetric map of Kattegat.
2. Map the distribution of fishing pressure.
   a. Use VMS recordings assigned to fishing (recordings with speed 2-4 knots) to map the distribution of effort (hours fished) for Danish and Swedish fishing fleet in 2007-2010.
   b. Estimate relative catchability from the individual fleet segments defined from the actual use of the gear types (Standard trawl, Swedish grid and SELTRA 300) and their selection pattern.
   c. Assume that fishing pressure is proportional to vessel engine size (kW)
   d. Estimate local fishing pressure from the sum of product of effort, catchability and engine size for the individual fleet segments.
3. Estimate the change in fishing impact (proxy for fishing mortality) on cod
   a. Overlay the spatial distribution ($0.05^{o}$ longitude x $0.05^{o}$ latitude) of fishing pressure and temporal distribution (quarter of the year) of the cod stock and fishing pressure.
   b. Assume that local fishing impact is proportional to the local fishing pressure and cod density.
   c. Integrate the estimated impact over all trawl positions from the cod distribution and local effort for the period 2007 to 2010

d. Raise the impact by the proportion of the total national kW-days included in VMS data.

The following text elaborates the approach.

## 1. Distribution of cod in Kattegat

### Available data

Survey coverage in Kattegat is relatively good, however most often covered by multi-purposed surveys. CPUE data for analysis of cod distribution were taken from the Kattegat area and a very limited area adjacent to Kattegat (Figure 2). By including the areas bordering Kattegat, the density of cod in the border areas of Kattegat can be estimated with less statistical uncertainty and minimise the edge effect in the abundance estimate.

For the first quarter of the year, data from two surveys are available. The ICES coordinated International Bottom Trawl Survey, (IBTS) provided around 20 stations by year in Kattegat and around 2-3 stations per year in the Skagerrak bordering Kattegat for the years 1985-2011. In some years, the IBTS is extended slightly south of the borderline between Kattegat and the Sound. Data from these 0-2 stations per year were included as well. IBTS covers mainly depths below 20 m. The Danish Havfisken survey (part of the BITS survey) covers also the more shallow waters. Data from this survey 1996-2011 are available including around 22 stations per year for Kattegat, 1-3 for the Sound and 1-3 for the neighbouring area in the Belt Sea.

No up to data time series is available for the second quarter.

For the third quarter the IBTS Quarter 3 data, 1991-2010 are available including around 20 stations per year in Kattegat.

The Danish/Swedish cod survey initiated in December 2008 is the only survey that covers the distribution area for cod in Kattegat. Eighty trawl hauls are made per year. Data for 2008 - 2010 were used to model the cod distribution in quarter 4.

IBTS and BITS (Havfisken) data were extracted from the ICES DATRAS database as catch at age per haul. Data from the Danish/Swedish cod survey were extracted from the “final-international” (Jørgensen et. al, 2011) catch at age data set.

### Statistical analysis

The relative cod density was modelled using a Generalized Additive Model (GAM) of the CPUE at age by haul as a function of position, depth, year and survey:

$$\text{CPUE} \sim \alpha + f1(\text{latitude x longitude}) + f2(\text{depth}) + f3(\text{year}) + \text{survey} + \varepsilon$$

where f1, f2 and f3 are smoothing functions and survey is a factor. Smooth terms are using penalized regression splines with the number of smoothing parameters selected as part of the model fitting. See Wood (2006) and Wood (2008) for more information. The R-package “mgcv” were used for analysis. For quarter four with only three years data, the year effect was modelled as a factor. For all analyses, non-significant model terms were removed from the final model.

The negative binomial distribution and log-link function was used to model CPUE. For some combinations of quarter and age group the quasi-Poisson distribution and a log-link function gave a better fit, but the predicted stock distribution was in some cases unrealistic, with very high densities in areas with few or no observations. For consistency the negative binomial distribution was used for all the final analysis.

In the model it is assumed that the stock distribution "f1(latitude x longitude)" is independent of the year. An analysis of the centre of gravity of the cod stock was performed on each survey time series, using only the trawl stations within the Kattegat. The centre of gravity is calculated as the average of each haul position (the start of the haul) weighted by the cod CPUE at age for that haul. Both the observed CPUE and the log(CPUE+1) as suggested by Rindorf and Lewy, (2006) were applied as weighting factor. Significance of the trend in position of the centre of gravity was estimated from correlation analysis between the latitude of the centre and the year. Alternately, the correlation of the first principal component score from PCA of the longitude and latitude, and the year was tested. Based on the results of these analyses, the time series for analysing the cod distribution was shorten, such that the assumption on a constant stock distribution was not violated.

#### Results

##### *Centre of gravity*

The positions of the average trawl positions by year and survey (Figure COG-1) show a rather stable centre of gravity for the position of trawl stations with random variation from one year to the next. There might however be a consistent, more northerly distribution of IBTS Q3 for the years 2006-2010, and a slightly different distribution of the stations in the IBTS Q1 in the period 1986-1989.

The centre of the gravity of trawl position weighted by catches by age group (Figure COG-2 to Figure COG-5) show a more disperse distribution area than for the unweighted trawl stations. Dispersion of the annual centres becomes less variable when it is calculated on the basis log(CPUE+1), however the two methods gives apparently a similar random distribution of the annual centres.

The latitude of the annual centre of the cod distribution seems randomly distributed, except for IBTS Q3 where the distribution has become more northerly in recent years (Figure COG-6). Based on correlation analysis between latitude and year the shift is statistical significant for age 0- to age 3+. The northern shift is larger and starts earlier than the small but consistent shift in IBTS Q3 trawl position since 2006, which indicate the shift is due to a change in stock distribution rather than just a shift in trawl stations. The more northerly distribution is also significant when the individual trawl station is weighted by log(CPUE+1) (Figure COG-7). Using the first PCA score as independent variable, the correlation between centre of gravity and year is only significant for age 1.

For modelling of the stock distribution, it is assumed that the stock distribution has been the same for the full time series of quarter 1 and quarter 4 data. For quarter 3 it is assumed that the distribution has been constant since 2001.

Summary: Analysis of the centre of gravity of cod survey catches for the winter period, quarter 1 and 4, do not show a consistent change in stock distribution for the last 20 years. The situation seems however different for the summer period, where a more northerly centre of gravity of cod catches in quarter 3 IBTS indicate a more northerly distribution for all ages of cod for the period since 1991.

##### *Stock distribution*

The results for the **quarter 1** regressions are shown in Table ANA-1 and Figure ANA-2 to ANA-4. Catch position, depth and year are highly significant model terms for ages 1, 2 and 3 plus. The Survey effect was not highly significant for age 2. Compared to the Havfisken survey, IBTS has lower catch rates of age 1 and 2, and higher catch rates for age 3 plus. The year effects (Figure ANA-2) for age 1, age 2 and 3plus show a clear downward trend for whole time series 1996-2011. For all the ages the "year effect" (stock abundance) has increased significantly since 2009. The predicted stock distribution (Figure ANA-4) is a rather dispersed for the 1 group cod with the highest concentration in the North-western Kattegat. Age 2 is mainly concentrated in the deeper eastern Kattegat and predominately in Kilen. The age 3 plus, which includes the most of the spawning stock, is concentrated in the permanently closed areas and in Kilen. As an example, Figure ANA-3 shows the uncertainties for the stock distribution. Coefficient of Variation follows in general the density of observations.

The depth effect was not significant for the quarter 3 analyses for age 1-2+(Table ANA-2). The pattern in Year effect (Figure ANA-6) for Age 2 and 2 plus in quarter 3 is very similar to the pattern estimated for quarter 1 (Figure ANA-2) with an increase in year effect (abundance) for age 2, age 2+ and age 3+. Age 2 plus cod is mainly concentrated in the north-eastern Kattegat, with part of the high concentration area within the "orange" closed area, where selective gears are mandatory. (Figure ANA-7). Depth effect is significant for age 3+, which probably adds to a slightly different distribution than the age 2+. However, as for the age 2+, high concentrations of age 3+ is found in the "orange" closed area.

The fourth quarter analysis (Table ANA-3) show a good fit for age 0 and age 3+. Age 1 abundance in 2010 is higher than in 2009, but higher than in 2008. For age 2 the abundance has increased since 2008, but the opposite is the case for age 3+. The predicted concentrations (Figure ANA-4) of age 0 and 1 are highest in the north-western Kattegat. Age 2 and older is distributed more southerly with high concentrations in the "orange" area.

### 2. Distribution of fishing effort from VMS

VMS records from fishing vessels with speed 2-4 knots were classified as "fishing" activity and afterwards merged with Logbook data by trip to allocate each trip to the fleet segments TR1, TR2 or "other" based on gear and mesh size information. In this process, misclassification of both vessel activity and segment might occur. Information on application of gear with a low cod catch (which allows fishery in area 3) is not available in the Danish logbooks. Swedish VMS data includes information on the application of the "Swedish sorting grid".

Figure VMS-1 and VMS-2 present the basic VMS data classified as "fishing" for the Danish and Swedish TR1 and TR2 segment for the period 2007-2010. The main part of the Danish and Swedish fisheries takes place on shared fishing ground in the eastern and deeper part of Kattegat, however the Danish fishery extents more easterly and southerly than the Swedish. Sweden had almost no activity in the permanent closed ("the red area") area in Kattegat and in the Sound ("Kilen") before the closure in 2009.

Effort from the TR1 segment (Figure VMS-4) has been relatively modest since 2007 with the highest density in Kilen before the closure in 2009. In 2010 the TR1 Effort was less than 1% of the TR2 effort.

The effect of the box closures in 2009 is clearly seen for the effort distribution in the first quarter (Figure VMS-5). Effort seems redistributed more westerly after the closure. For the second quarter, effort in the "red" area (closed for all commercial fisheries) was close to zero in 2009, however with some activities in 2010. Effort in the "orange" area (closed for all fisheries except fisheries with selective gears with very low catch of cod, Swedish grid or SELTRA 300) has increased significantly in 2010 and seems to be the most important area in the second quarter. A similar increase in effort over the years 2007-2010 in the "orange" area is also seen for quarter 3 (Figure VMS-6), while effort in the "orange" area seems to have decreased for quarter 4. The decrease is quarter 4 is probably due to the mandatory use of grid or SELTRA 300, which has a very low catchability of sole that is mainly caught in the late autumn.

Fishery (VMS records) with grid has increased 4 fold since 2007 (Figure VMS-7). In 2010, the highest concentration of effort is found in the "orange" area. The "Swedish sorting grid" is not applied by the Danish fishermen.

Effort distribution in 2010 by month (Figure VMS-8a) shows very limited activity in the closed areas in January-March. From April onwards, there is no restriction for the "black" area which is also reflected in the effort distribution. Fisheries in the "Orange" area is allowed in the period 1st April – 31th December with selective gears (Swedish grid or SELTRA 300). Application of the Swedish grid (Figure VMS-8c) shows a relative high concentration of effort within the orange area, especially in the summer months. The same pattern is seen for the rest of the TR2 segment (Figure VMS-8b). Fishery with SELTRA 300 is also allowed in the "orange" area, but there is no information in the electronic version of the logbook data about the actually use of that gear, to confirm an actual application of that gear. The "red" area closed for all fisheries contains some VMS "fishing activity" in April-August which cannot be due to misclassification of vessel activity. Almost no VMS "fishing activity" is recorded from September and onwards. This may be linked to the press release of the Greenpeace campaign the 22. August 2010, that showed clear evidence of fishery in the "red" area by Danish fishermen from Gilleleje (a harbour in the Southern Kattegat).

Based on the calculated centre of gravity of the fishing effort by year and quarter (Figure VMS-9), the large scale changes in effort distribution since 2007 have been rather modest. Quarter 2 seem to be the only quarter where the centre of gravity has changed significantly, with a clearly more south-easterly distribution in 2010. This is due to the steep increase in effort in the "orange" area in 2010 (Figure VMS-5).

The same conclusion about a stable fishing pattern can be derived from the fished area by year and month (Figure VMS-11). The area covered differs significantly between years for the months January-March with the main closures. A mandatory use of sorting grid in the February – April of 2008 had also clearly reduced the activity in that period, and given a higher activity in May. The area fished was relatively high in March-May of 2010, probably linked to an increase in the number VMS records and a more north-westerly distribution in March (Figure VMS-5).

Summary: The introduction of closed Kattegat areas in 2009 had, as intended, given a very low effort in the affected areas in the first quarter of 2009 and 2010. Total annual effort (VMS record) seems however to have been stable (2009) or increased (2010) since the closure. For both years, quarter 1 effort was reallocated outside the closed areas, mainly to the more eastern grounds. The second quarter of 2009 had a very low effort in the area where fishery is allowed, 1st April to 31th December with gears with low catch of cod (Swedish grid or SELTRA 300). This pattern changed significantly in 2010 where this area had the highest concentration of effort in the time series (2007-2010). The reason for this change is not investigated further, but it might be linked to a higher CPUE of especially larger *Nephrops* in the area due to the area closure the year before. As cod selective gears are mandatory in the area, a shift to such gears will decrease the fishing impact (discards) on cod significantly, even though the concentration of cod is relatively high in the area. The change in effort distribution for quarter 3, with an increase of effort in the area with mandatory use of selective gears, seems similar to the changes observed for quarter 2. The decrease in effort in the first year of closure was however not that pronounced as for the second quarter, which indicates fast adaptation to the closures.  Total effort (VMS records) in quarter 4 has decreased substantially since 2007.

The closure of the northern Sound ("Kilen") has almost entirely removed effort by segment TR1 and TR2 in the area.

### 3. Fishing impact on cod for the period 2007–2010

The TR2 segment is by far the most important with respect to cod landings and effort (Tables 1 and 2). Consequently this analysis focuses on the TR2 segment.

#### Method

Fishing impact (proxy for Fishing mortality) is here defined as

$Impact_{lon,lat,year,quarter,selGroup,age} = density_{lon,lat,quarter,age} * effort_{lon,lat,year,quarter,selGroup} * catchability_{SelGroup} *$

where

> density is the proportion of the cod stock (at age) in Kattegat within a given position (longitude, latitude grid, 0.01 x 0.01 degree) for a given quarter.
>
> effort is the fishing activity given by the number of VMS "fishing" records times  engine power (kW)
>
> catchability is the cod catchability relative to a standard gear (set at 1.0). Catchability is set to 0.1 for gears with logbook recorded use of sorting grid and for vessels fishing in areas/periods where uses of selective gears (sorting grid or SELTRA 300) are mandatory.

The impact from the fleet equipped with VMS is raised to total impact from the total TR2 segment from data on the proportion of total national effort by year and quarter coming from vessels equipped with VMS (Table 3).  It is thereby assumed that large and small vessels have the same use of selective gears and the same exploitation pattern.

"density" is derived from the predicted cod distribution within Kattegat, e.g. figure ANA-4 and "effort" is from the national VMS data. Both data sources are used on a 0.01 x 0.01 degree grid. In cases of no information on use of selective gears, it is assumed that vessels fishing in the "orange" closed areas in the period 1st April to 31th December, or in the ""black" area 1st Jan to 31th March use selective gears (sorting grid or SELTRA 300). Vessels fishing illegally in the permanently closed "red" area or are assumed to use a standard gear.

The relative catchability of the cod selective gears is crucial to the result of this analysis. Experiments conducted by DTU Aqua with SELTRA codends (300-400 mm square- mesh panels) have documented that about 90% of the cod that enters the trawl will escape through the large meshes of the square-mesh panel (see Annex 1 for more details). Due to a misunderstanding in reading the SELTRA 300 specification, the constructed and applied "SELTRA 300" has actually been SELTRA 600 (600mm meshes in the escape window). This application of this larger mesh size will increase cod escapement.

As sensitivity analysis, the analysis assuming a 10% catchability of cod selective gears was re-calculated assuming a 5% or 25% relative catchability in cod selective gears.

### Results

Fishing impact on Kattegat cod from the TR2 segment has decreased in the period 2007-2010 for all ages (Table 5). Relative to fishing impact in 2007 the impact in 2010 is around 63% for all age groups (Table 6), which is equivalent to an annual decrease of around 14% (Table 7). The sensitivity to the applied catchability reduction factor (Table 8) show that the F reduction in 2009 is rather insensitive to the assumption on catchability as the t F reduction is mainly due to the relocation of effort from the closed (high cod density) areas to areas with lower cod density. For 2010 the decrease in F is however more closely linked to the assumed catchability changes as nominal effort has increased significantly in the areas where cod selective gears are mandatory.

## Discussion

The uncertainty of the estimated fishing impact cannot be ignored. Around 40% of the effort in Kattegat is from small vessels without VMS. It is assumed that the smaller vessels have the same exploitation pattern of cod with respect to fishing ground, time of the year and use of selective gears. This might not be the case, and might bias the result.

It is also assumed, that selective gears are used when noted in the logbook or during fishery in the closed areas where such gears are mandatory. We have information from the Danish fishery that SELTRA 300 is used, both inside and outside the closed areas, but statistics from enforcement is not available. In the analysis it is assumed that SELTRA 300 is only used in the closed areas. Application SELTRA 300 outside the closed areas will result in a decrease in F. A mandatory registration in the logbooks of the use of selective gears is recommended.

The reduction in F (fishing impact) of around 14% per years is just estimated for the TR2 segment, which is by far the most important with respect to effort and historical cod landings. The absolute decrease in effort in other segment has been rather limited in the most recent years, but will also contribute to a further decrease in F.

This paper has not analysed directly which management measure that have been the most important in reducing F. Total effort (kW-days) has not been reduced since 2008. The nominal effect outside the closed area was highest in the first year of closure as effort was removed from areas with the highest cod densities. Later on, a shift to selective gears has made it possible to increase effort in the closed areas considerably; however this fishery has (apparently) taken place with selective gears with low catch of cod.

### References


Jørgensen,O.A., M. Storr-Paulsen, K. Ringdahl, J. Lövgren. (2011). Joint Swedish and Danish survey for cod in the Kattegat December 2010". Working document to ICES WGNBFAS, 2011.

Rindorf, A., Lewy, P. (2006). Warm, windy winters drive cod north and homing of spawners keeps them there. Journal of Applied Ecology, 43: 445-453.

Wood, S.N. (2006) . On confidence intervals for generalized additive models based on penalized regression splines. Australian and New Zealand Journal of Statistics. 48(4): 445-464.

Wood, S.N. (2008). Fast stable direct fitting and smoothness selection for generalized additive models. J.R.S

**Table 1. Overview of effort (mega Watt days) by segment and year for the Kattegat fishery as used in the analysis.**

DENMARK

| Gear Segment | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| TR1 | 190 | 159 | 102 | 70 |
| TR2 | 2,027 | 2,153 | 2,214 | 2,382 |
| TR3 | 306 | 152 | 93 | 36 |
| GN | 73 | 66 | 82 | 67 |
| GT | 12 | 12 | 23 | 14 |
| LL | | | <1 | |

SWEDEN

| Gear Segement | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| TR1 | 20 | 58 | 7 | 14 |
| TR2 (%SPECON) | 1275 (18) | 1228 (25) | 852 (49) | 767 (63) |
| TR3 | 1 | 0 | 1 | 0 |
| GN | 15 | 33 | 33 | 33 |
| GT | 34 | 29 | 18 | 27 |
| LL | 38 | 25 | 0 | 0 |

**Table 2. Landings (tonnes) of Kattegat cod by gear segment.**

DENMARK

| Kattegat<br>Gear segment | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| GN | 42 | 36 | 37 | 35 | 39 | 15 | |
| GT | 9 | 2 | 4 | 3 | 1 | 1 | |
| LL | 2 | 0 | 2 | 1 | 0 | 0 | |
| TR1 | 68 | 83 | 39 | 52 | 26 | 17 | |
| TR2 | 536 | 344 | 349 | 255 | 181 | 86 | |

SWEDEN

| Gear segment | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| GN | 1 | 2 | 4 | 2 | 11 | 2 | 0 |
| GT | 6 | 5 | 1 | 2 | 3 | 1 | 0 |
| LL | 0 | 1 | 3 | 0 | 14 | 0 | 0 |
| TR1 | 35 | 25 | 8 | 31 | 7 | 1 | 1 |
| TR2 | 398 | 284 | 282 | 198 | 117 | 35 | 27 |

**Table ANA-1. Regression results of GAM analysis of CPUE at age as function of trawl position(x,y), depth and survey, Quarter 1.**

## Age 1

```
Family: Negative Binomial(0.728) Link function: log
Formula: Age_1 ~ s(x, y) + s(Depth) + s(Year) + Survey

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  3.45488    0.06819  50.667  < 2e-16 ***
SurveyIBTS  -0.87537    0.10977  -7.975 1.53e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
            edf Ref.df Chi.sq  p-value
s(x,y)   25.479 28.208 116.47 1.09e-12 ***
s(Depth)  6.812  7.930  52.08 1.51e-08 ***
s(Year)   8.256  8.848 221.39  < 2e-16 ***
---
R-sq.(adj) =  0.209   Deviance explained = 43.1%
UBRE score = 0.28425  Scale est. = 1        n = 714
```

## Age 2

```
Family: Negative Binomial(0.79) Link function: log
Formula: Age_2 ~ s(x, y) + s(Depth) + s(Year)
Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  2.39315    0.06231   38.41   <2e-16 ***

Approximate significance of smooth terms:
            edf Ref.df Chi.sq  p-value
s(x,y)   24.644 27.648 274.71  < 2e-16 ***
s(Depth)  8.580  8.911  48.11 2.25e-07 ***
s(Year)   8.896  8.997 503.41  < 2e-16 ***

R-sq.(adj) =   0.16   Deviance explained = 55.8%
UBRE score = 0.21468  Scale est. = 1        n = 714
```

## Age 3+

```
Family: Negative Binomial(0.999) Link function: log
Formula: Age_3Plus ~ s(x, y) + s(Depth) + s(Year) + Survey
Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  0.91500    0.08269  11.066  < 2e-16 ***
SurveyIBTS   0.54686    0.10334   5.292 1.21e-07 ***

Approximate significance of smooth terms:
            edf Ref.df Chi.sq p-value
s(x,y)   24.358 27.240 412.38 < 2e-16 ***
s(Depth)  3.669  4.659  45.83 6.4e-09 ***
s(Year)   8.799  8.988 358.55 < 2e-16 ***

R-sq.(adj) =   0.22   Deviance explained = 63.1%
UBRE score = 0.13759  Scale est. = 1        n = 714
```

**Table ANA-2. Regression results of GAM analysis of CPUE at age as function of trawl position(x,y) year and depth, Quarter 3.**

## Age 1

```
Family: Negative Binomial(1.308) Link function: log

Formula:Age_1 ~ s(x, y) + s(Year)
Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  1.12514    0.08245   13.65   <2e-16 ***

Approximate significance of smooth terms:
           edf Ref.df Chi.sq p-value
s(x,y)  24.400 26.989  164.0  <2e-16 ***
s(Year)  8.943  8.999  216.9  <2e-16 ***
---
R-sq.(adj) =  0.501   Deviance explained = 69.7%
UBRE score = 0.37077  Scale est. = 1         n = 223
```

## Age 2

```
Family: Negative Binomial(1.998) Link function: log
Formula:Age_2 ~ s(x, y) + s(Year)

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.0953     0.2123  -5.159 2.48e-07 ***
---
Approximate significance of smooth terms:
           edf Ref.df Chi.sq  p-value
s(x,y)  15.862 19.176  159.4  < 2e-16 ***
s(Year)  8.042  8.732   68.8 1.95e-11 ***
---
R-sq.(adj) =  0.564   Deviance explained = 76.2%
UBRE score = -0.12441  Scale est. = 1         n = 223
```

## Age 2+

```
Family: Negative Binomial(2.048) Link function: log
Formula:Age_2Plus ~ s(x, y) + s(Year)

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -0.7523     0.1565  -4.806 1.54e-06 ***
---
Approximate significance of smooth terms:
           edf Ref.df Chi.sq  p-value
s(x,y)  18.179 21.156 205.36  < 2e-16 ***
s(Year)  7.384  8.357  87.81 2.02e-15 ***
---
R-sq.(adj) =  0.506   Deviance explained = 77.2%
UBRE score = -0.036866  Scale est. = 1         n = 223
```

## Age 3+

```
Family: Negative Binomial(1.434) Link function: log
Formula: Age_3Plus ~ s(x, y) + s(Year) + s(Depth)

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.6318     0.3695  -7.122 1.07e-12 ***
---
Approximate significance of smooth terms:
           edf Ref.df Chi.sq  p-value
s(x,y)   9.334 12.159  28.53  0.00503 **
s(Year)  8.116  8.773  52.98 2.37e-08 ***
s(Depth) 2.833  3.389  13.37  0.00566 **
---
R-sq.(adj) =  0.399   Deviance explained = 71.7%
UBRE score = -0.36198  Scale est. = 1         n = 223
```

**Table ANA-3. Regression results of GAM analysis of CPUE at age as function of trawl position(x,y), depth and year, Quarter 4.**

## Age 0

```
Family: Negative Binomial(0.892) Link function: log
Formula:Age_0 ~ s(x, y) + factor(Year) + s(Depth) + Survey

Parametric coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)        1.3806     0.1263  10.928  < 2e-16 ***
factor(Year)2009  -1.2741     0.1818  -7.010 2.39e-12 ***
factor(Year)2010  -0.8886     0.1725  -5.152 2.57e-07 ***
SurveyHavF         1.9648     0.1812  10.841  < 2e-16 ***
---
Approximate significance of smooth terms:
           edf Ref.df Chi.sq p-value
s(x,y)   13.23 17.728 119.25  <2e-16 ***
s(Depth)  3.75  4.625  11.99  0.0273 *
---
R-sq.(adj) =  0.543   Deviance explained =   64%
UBRE score = 0.23099  Scale est. = 1         n = 307
```

## Age 1

```
Family: Negative Binomial(1.998) Link function: log
Formula: Age_1 ~ s(x, y) + factor(Year) + s(Depth) + Survey
Parametric coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)        1.4871     0.0934  15.922  < 2e-16 ***
factor(Year)2009   1.2627     0.1187  10.640  < 2e-16 ***
factor(Year)2010   0.8615     0.1177   7.321 2.45e-13 ***
SurveyHavF        -0.6128     0.1346  -4.552 5.33e-06 ***
---
Approximate significance of smooth terms:
            edf Ref.df Chi.sq  p-value
s(x,y)   21.002 25.566 83.385 4.77e-08 ***
s(Depth)  1.007  1.012  3.641   0.0574 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.315   Deviance explained = 50.6%
UBRE score = 0.063617  Scale est. = 1         n = 307
```

## Age 2

```
Family: Negative Binomial(3.263) Link function: log

Formula: Age_2 ~ s(x, y) + s(Depth) + factor(Year) + Survey

Parametric coefficients:
                  Estimate Std. Error z value Pr(>|z|)
(Intercept)       0.523050   0.108672   4.813 1.49e-06 ***
factor(Year)2009  0.001898   0.137577   0.014    0.989
factor(Year)2010  0.621721   0.124313   5.001 5.70e-07 ***
SurveyHavF       -0.705379   0.164903  -4.278 1.89e-05 ***
---
Approximate significance of smooth terms:
            edf Ref.df Chi.sq  p-value
s(x,y)   20.463 24.686  57.11 0.000223 ***
s(Depth)  2.325  2.956  16.33 0.000925 ***
---
R-sq.(adj) =  0.305   Deviance explained = 49.9%
UBRE score = 0.1736  Scale est. = 1         n = 307
```

**Table ANA-3 (continued). Regression results of GAM analysis of CPUE at age as function of trawl position(x,y), depth and year, Quarter 4.**

## Age 2+

```
Family: Negative Binomial(2.401) Link function: log

Formula:Age_2Plus ~ s(x, y) + s(Depth) + factor(Year) + Survey

Parametric coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)       1.17471    0.10294  11.411  < 2e-16 ***
factor(Year)2009 -0.34778    0.13257  -2.623   0.0087 **
factor(Year)2010  0.08562    0.12411   0.690   0.4903
SurveyHavF       -0.83717    0.16699  -5.013 5.35e-07 ***
---
Approximate significance of smooth terms:
            edf Ref.df Chi.sq  p-value
s(x,y)   19.238 23.694  74.64 3.53e-07 ***
s(Depth)  3.115  3.923  16.13  0.00266 **
---
R-sq.(adj) =  0.289   Deviance explained = 51.1%
UBRE score = 0.22888  Scale est. = 1         n = 307
```

## Age 3+

```
Family: Negative Binomial(3.475) Link function: log

Formula: Age_3Plus ~ s(x, y) + s(Depth) + factor(Year) + Survey

Parametric coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)        0.2899     0.1473   1.968    0.049 *
factor(Year)2009  -1.0499     0.1692  -6.205 5.47e-10 ***
factor(Year)2010  -2.1402     0.2304  -9.290  < 2e-16 ***
SurveyHavF        -1.7790     0.4218  -4.218 2.46e-05 ***
---
Approximate significance of smooth terms:
           edf Ref.df Chi.sq p-value
s(x,y)   11.21  15.04 119.28 < 2e-16 ***
s(Depth)  1.00   1.00  10.41 0.00125 **
---
R-sq.(adj) =  0.405   Deviance explained = 70.2%

UBRE score = -0.16493  Scale est. = 1         n = 307
```

**Table 3. Proportion (%) of annual nominal effort by year**

DENMARK

| year | Unknown | GN | GT | LL | TR1 | TR2 | TR3 |
|---|---|---|---|---|---|---|---|
| 2007 | 12.7 | 2.4 | 0.4 | NA | 6.2 | 68.1 | 10.2 |
| 2008 | 10.3 | 2.3 | 0.4 | NA | 5.5 | 76.2 | 5.2 |
| 2009 | 11.8 | 2.9 | 0.8 | 0.0 | 3.6 | 77.7 | 3.3 |
| 2010 | 11.3 | 2.3 | 0.5 | NA | 2.4 | 82.2 | 1.3 |

**Table 4. Proportion (%) of annual nominal TR2 effort from vessels equipped with VMS.**

| | | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|---|
| DNK | 2007 | 66 | 53 | 61 | 62 |
| | 2008 | 76 | 55 | 57 | 62 |
| | 2009 | 61 | 56 | 56 | 57 |
| | 2010 | 70 | 59 | 62 | 60 |
| SWE | 2007 | 58 | 64 | 67 | 58 |
| | 2008 | 54 | 50 | 60 | 48 |
| | 2009 | 68 | 70 | 72 | 62 |
| | 2010 | 72 | 74 | 78 | 68 |

**Table 5. Fishing impact (arbitrary unit) for the TR2 segment.**

| | age | Age 1 | Age 2 | Age 2+ | Age 3+ |
|---|---|---|---|---|---|
| year | | | | | |
| 2007 | Q1 | 325 | 353 | 359 | 395 |
| | Q2 | 284 | 292 | 292 | 297 |
| | Q3 | 682 | 688 | 678 | 940 |
| | Q4 | 343 | 451 | 460 | 503 |
| 2008 | Q1 | 224 | 264 | 267 | 284 |
| | Q2 | 279 | 268 | 277 | 285 |
| | Q3 | 620 | 692 | 690 | 881 |
| | Q4 | 347 | 460 | 459 | 483 |
| 2009 | Q1 | 194 | 225 | 221 | 223 |
| | Q2 | 263 | 259 | 259 | 252 |
| | Q3 | 477 | 503 | 501 | 682 |
| | Q4 | 240 | 295 | 309 | 355 |
| 2010 | Q1 | 237 | 248 | 241 | 237 |
| | Q2 | 208 | 249 | 264 | 280 |
| | Q3 | 347 | 345 | 343 | 474 |
| | Q4 | 210 | 282 | 290 | 330 |

| | Age 1 | Age 2 | Age 2+ | Age 3+ |
|---|---|---|---|---|
| year | | | | |
| 2007 | 1634 | 1784 | 1789 | 2134 |
| 2008 | 1469 | 1684 | 1693 | 1932 |
| 2009 | 1174 | 1282 | 1289 | 1511 |
| 2010 | 1003 | 1125 | 1139 | 1321 |

**Table 6. Relative Fishing impact for the TR2 segment.**

| year | age Age 1 | Age 2 | Age 2+ | Age 3+ |
|---|---|---|---|---|
| 2007 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2008 | 0.90 | 0.94 | 0.95 | 0.91 |
| 2009 | 0.72 | 0.72 | 0.72 | 0.71 |
| 2010 | 0.61 | 0.63 | 0.64 | 0.62 |

**Table 7. Change in Fishing impact (%) from one year to the next for the TR2 segment.**

| year | age Age 1 | Age 2 | Age 2+ | Age 3+ |
|---|---|---|---|---|
| 2008 | -10 | -6 | -5 | -9 |
| 2009 | -20 | -24 | -24 | -22 |
| 2010 | -15 | -12 | -12 | -13 |

**Table 8. Sensitivity analysis of the change in Fishing impact (%) from one year to the next for the TR2 segment.**

**Catchability of cod in "cod selective gears" is assumed 5% of the catchability for reference gears.**

| year | Age 1 | Age 2 | Age 2+ | Age 3+ |
|---|---|---|---|---|
| 2008 | -11 | -6 | -6 | -10 |
| 2009 | -20 | -24 | -24 | -21 |
| 2010 | -16 | -14 | -14 | -16 |

**Catchability of cod in "cod selective gears" is assumed 25% of the catchability for reference gears.**

| year | Age 1 | Age 2 | Age 2+ | Age 3+ |
|---|---|---|---|---|
| 2008 | -8 | -3 | -3 | -7 |
| 2009 | -20 | -24 | -24 | -23 |
| 2010 | -11 | -7 | -6 | -5 |

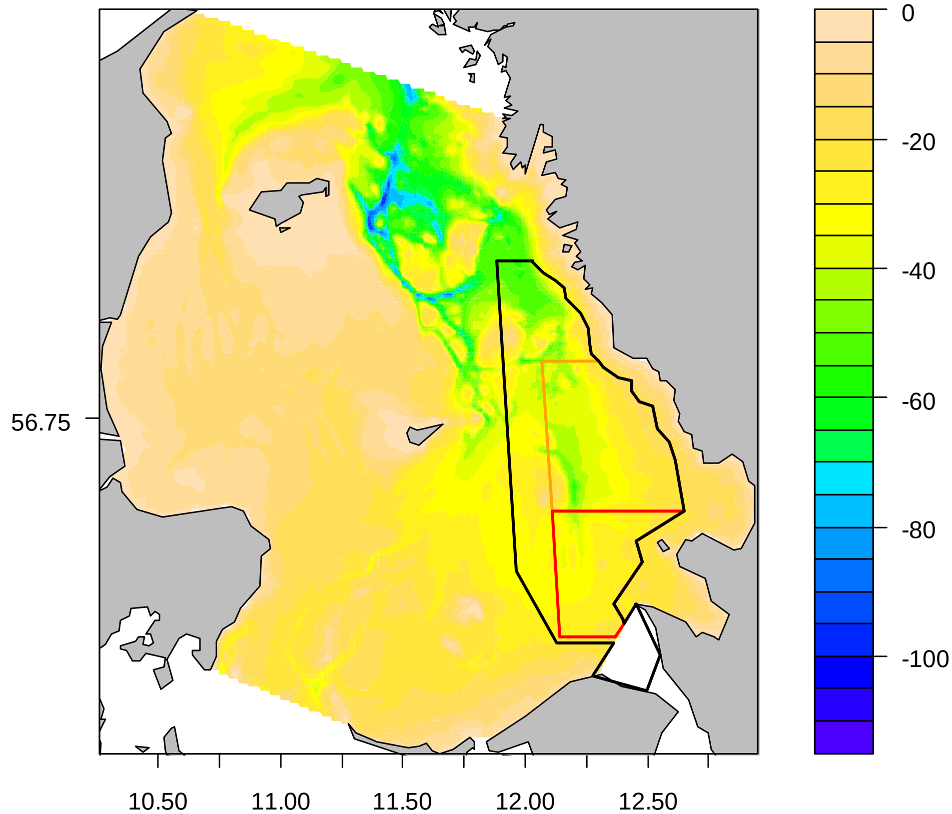



**Figure 1. Bathymetry of Kattegat.Closed areas:**

- Area 1: The "black" area is closed during the period 1st January-31th March, except for fishery with selective gears; The "black" area in the Northern Sound ("Kilen" or the Triangle) is closed 1st February -31th March, except for fishery with selective gears;
- Area 2. The "orange" area is closed for all fisheries in the period 1st January-31th March. Fisheries with selective gears is allowed 1st April - 31th December;
- Area 3: The "red" area is closed for all fisheries, including recreational fisheries;

**"Selective gears" refers to trawls equipped with sorting grid or SELTRA 300;**

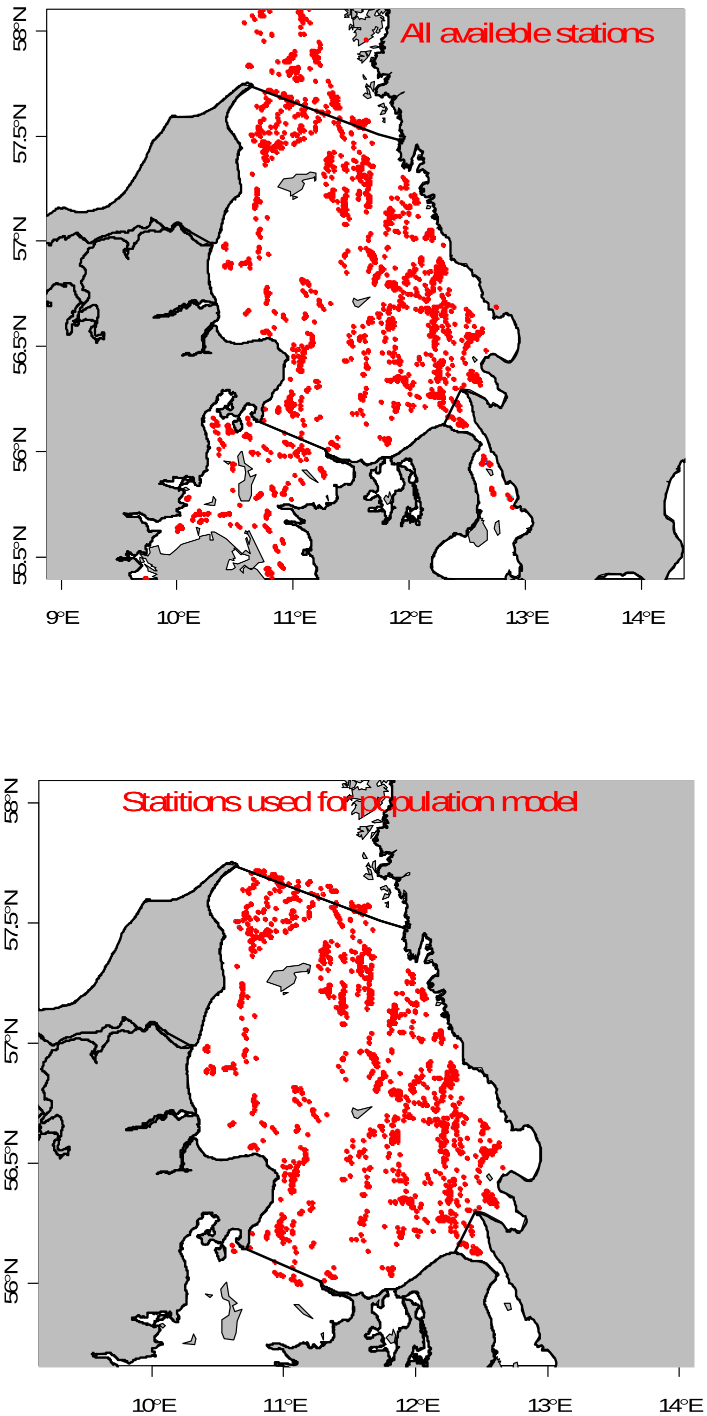



**Figure 2. Upper panel: position of trawl stations for the full data set. Lower panel: positions of trawl stations used for modelling population abundance. The borderlines for Kattegat are shown on the map.**

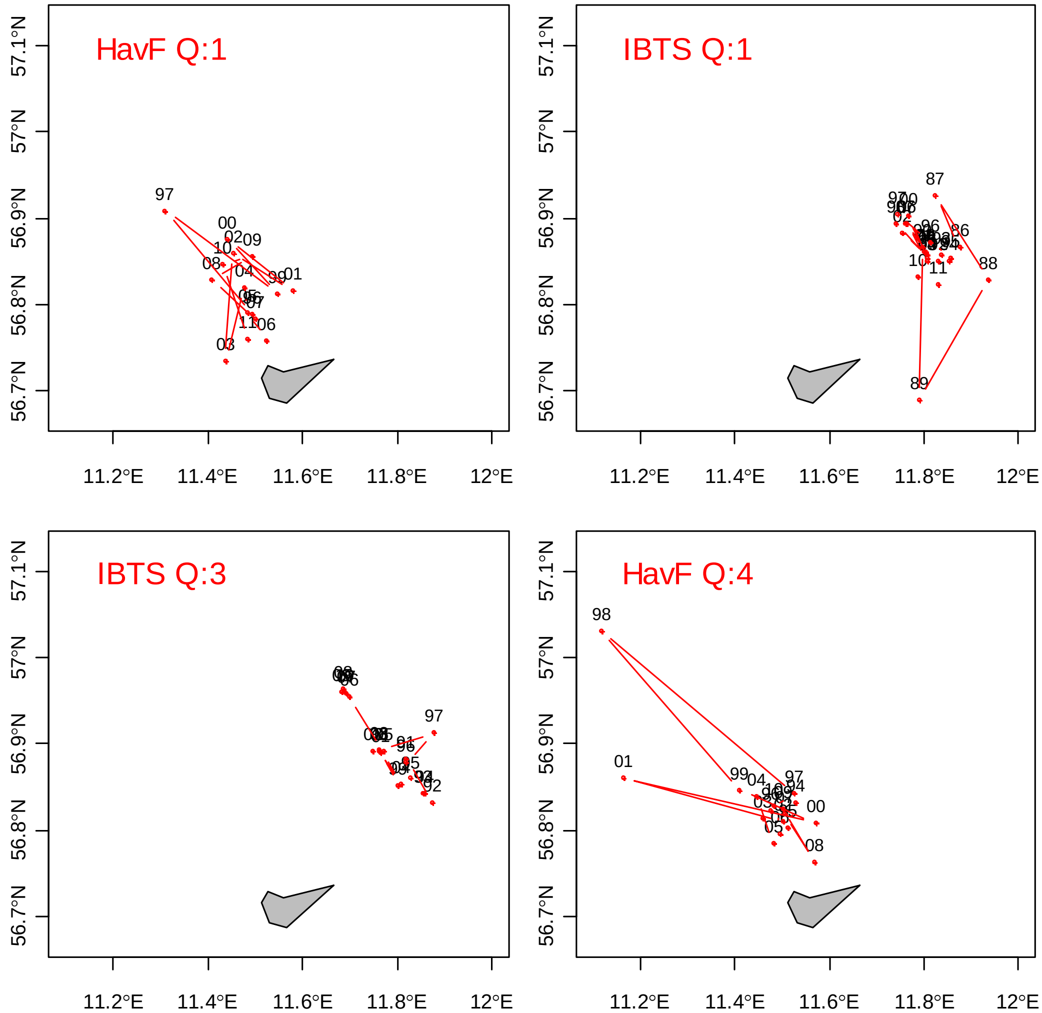



**Figure COG-1. Centre of gravity for trawl stations in the Quarter 1 Havfisken, Quarter 1 IBTS, Quarter 3 IBTS and Quarter 4 Havfisken surveys.**

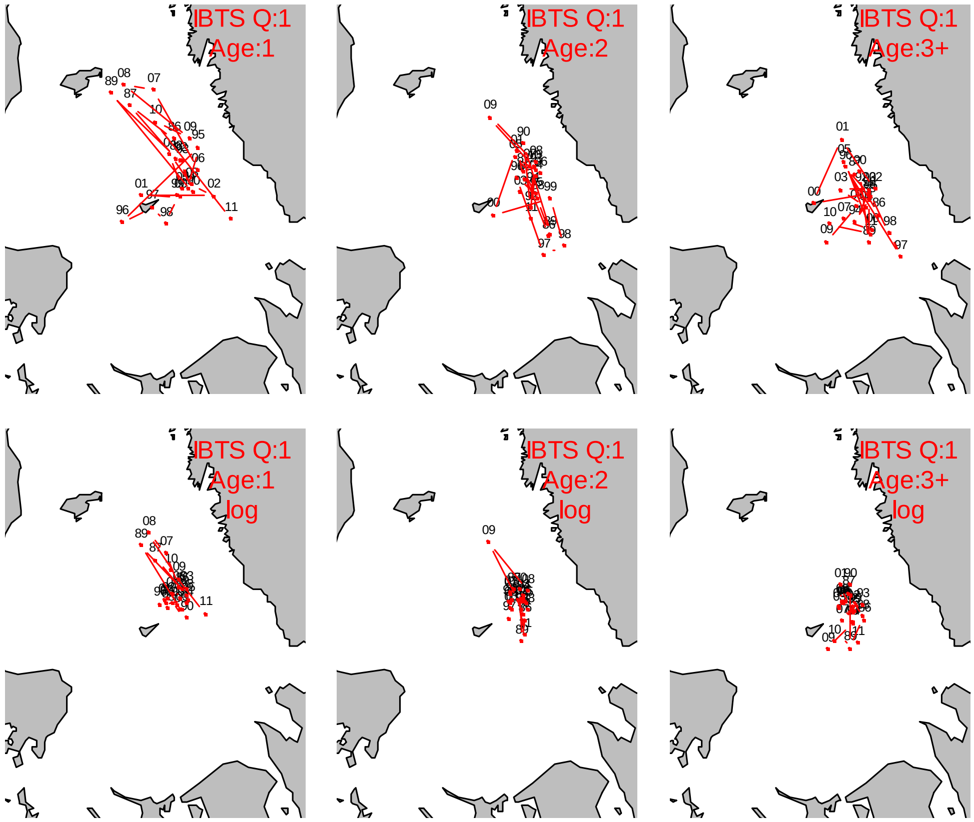



**Figure COG-2. Centre of gravity IBTS quarter 1. The centre by year represents the weighted average of haul positions, weighted by CPUE or alternatively log(CPUE+1).**

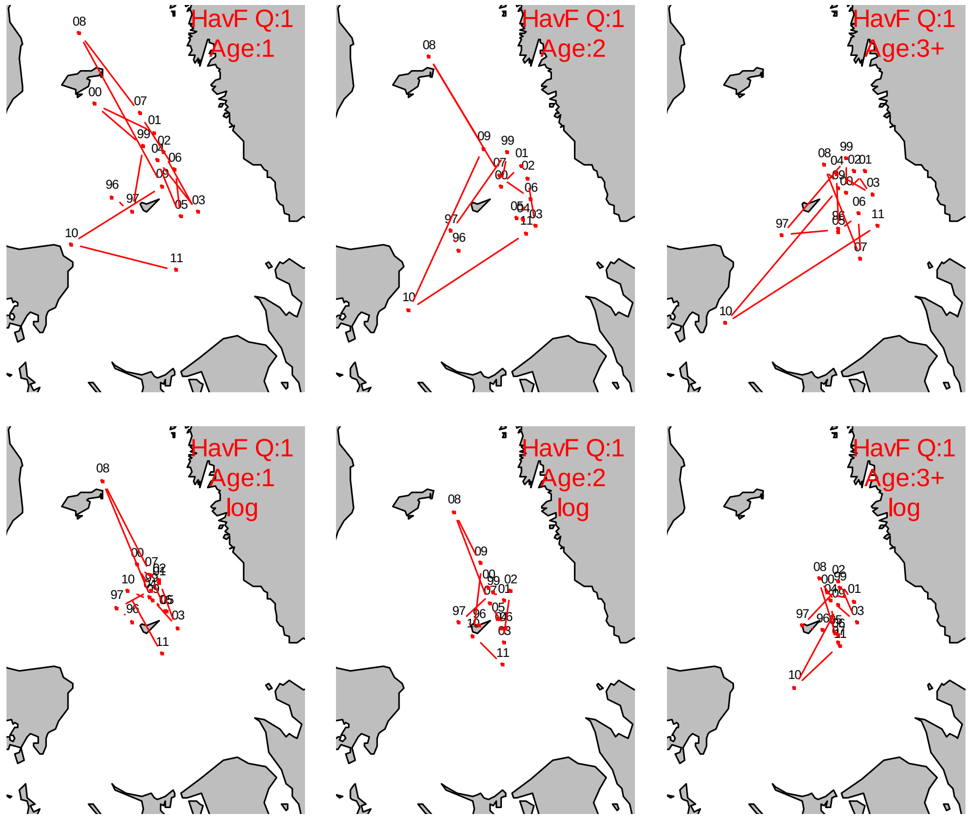



**Figure COG-3. Centre of gravity Havfisken quarter 1. The centre by year represents the weighted average of haul positions, weighted by CPUE or alternatively log(CPUE+1).**

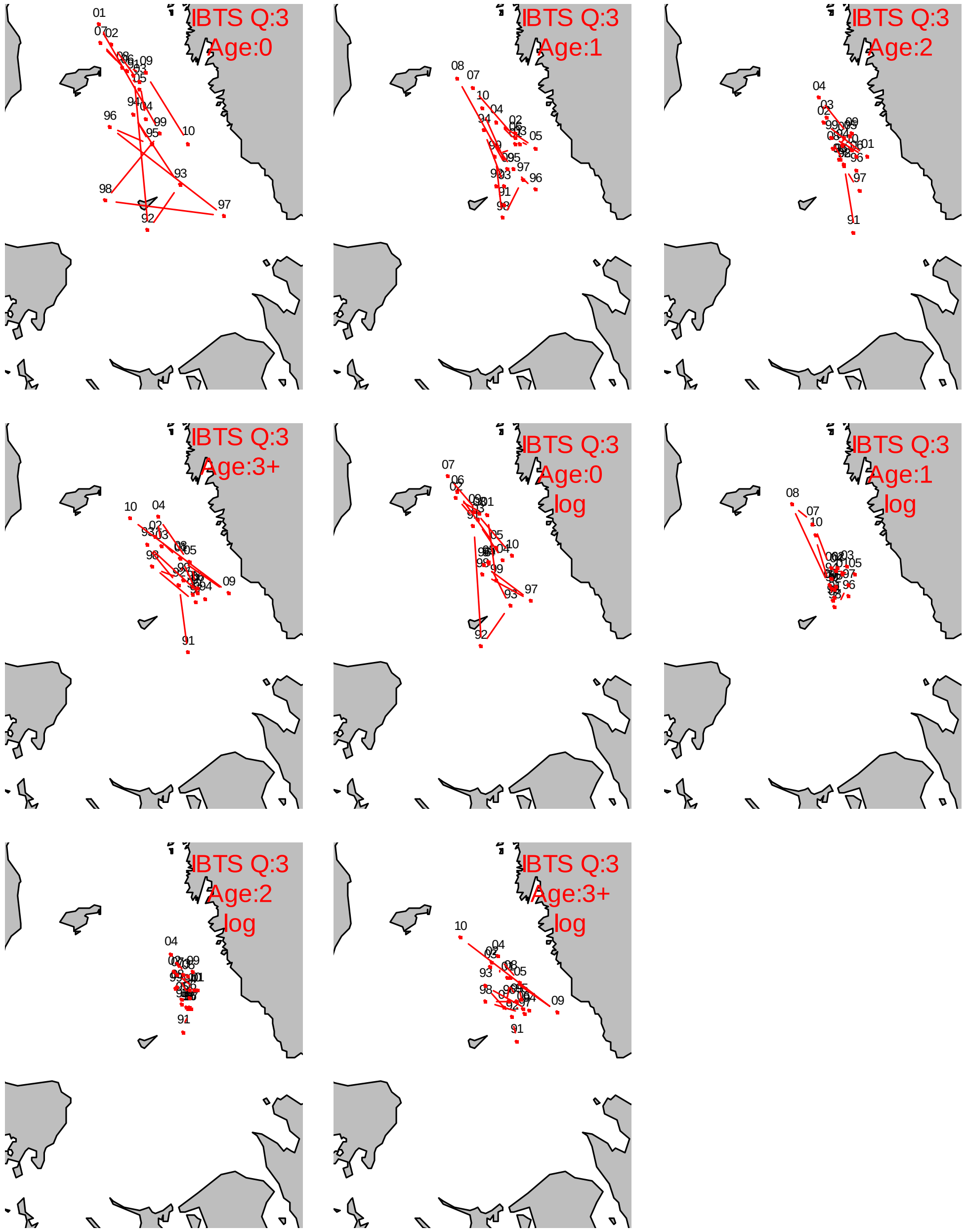



**Figure COG-4. Centre of gravity IBTS quarter 3. The centre by year represents the weighted average of haul positions, weighted by CPUE or alternatively log(CPUE+1).**

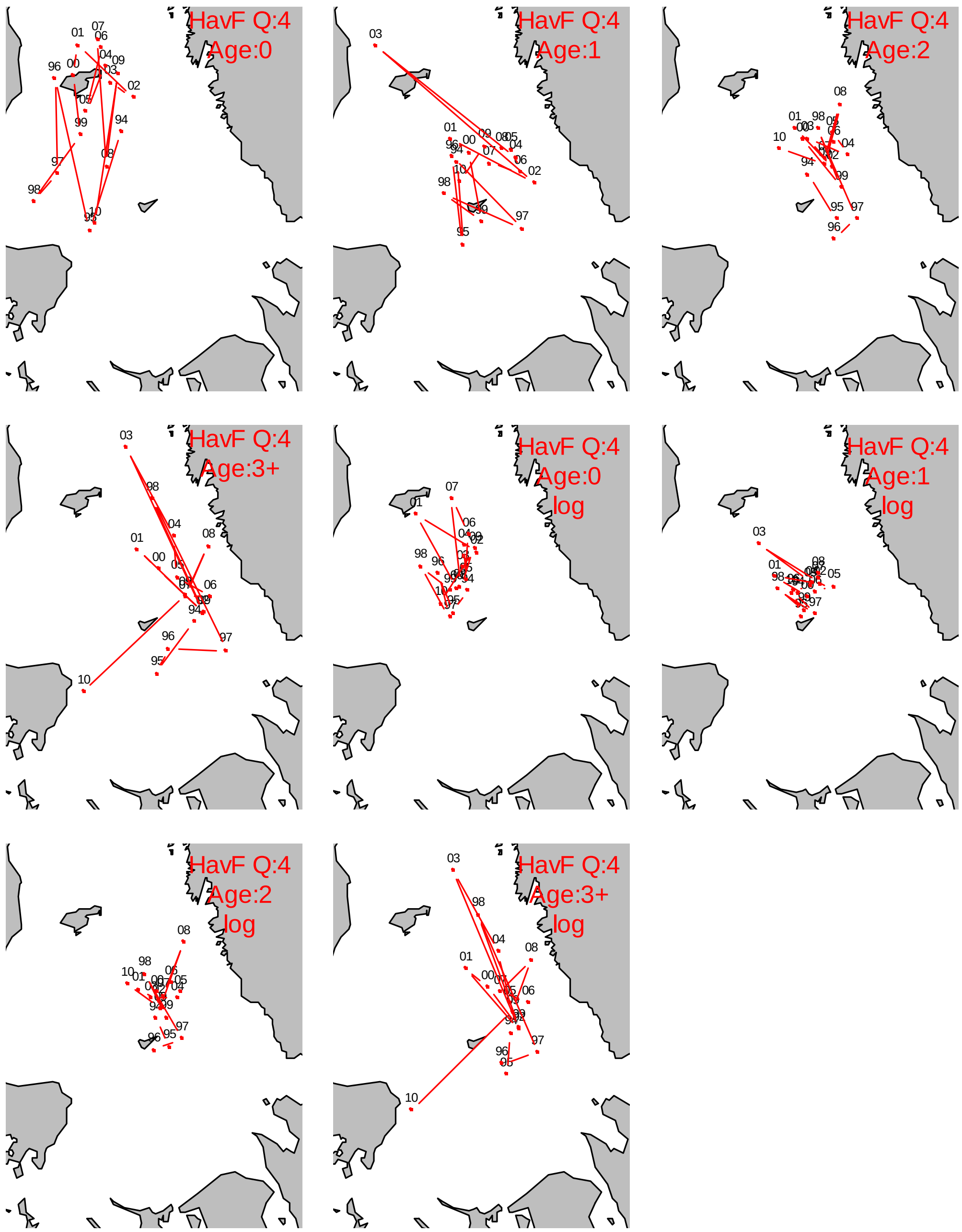



**Figure COG-5. Centre of gravity Havfisken quarter 4. The centre by year represents the weighted average of haul positions, weighted by CPUE or alternatively log(CPUE+1).**

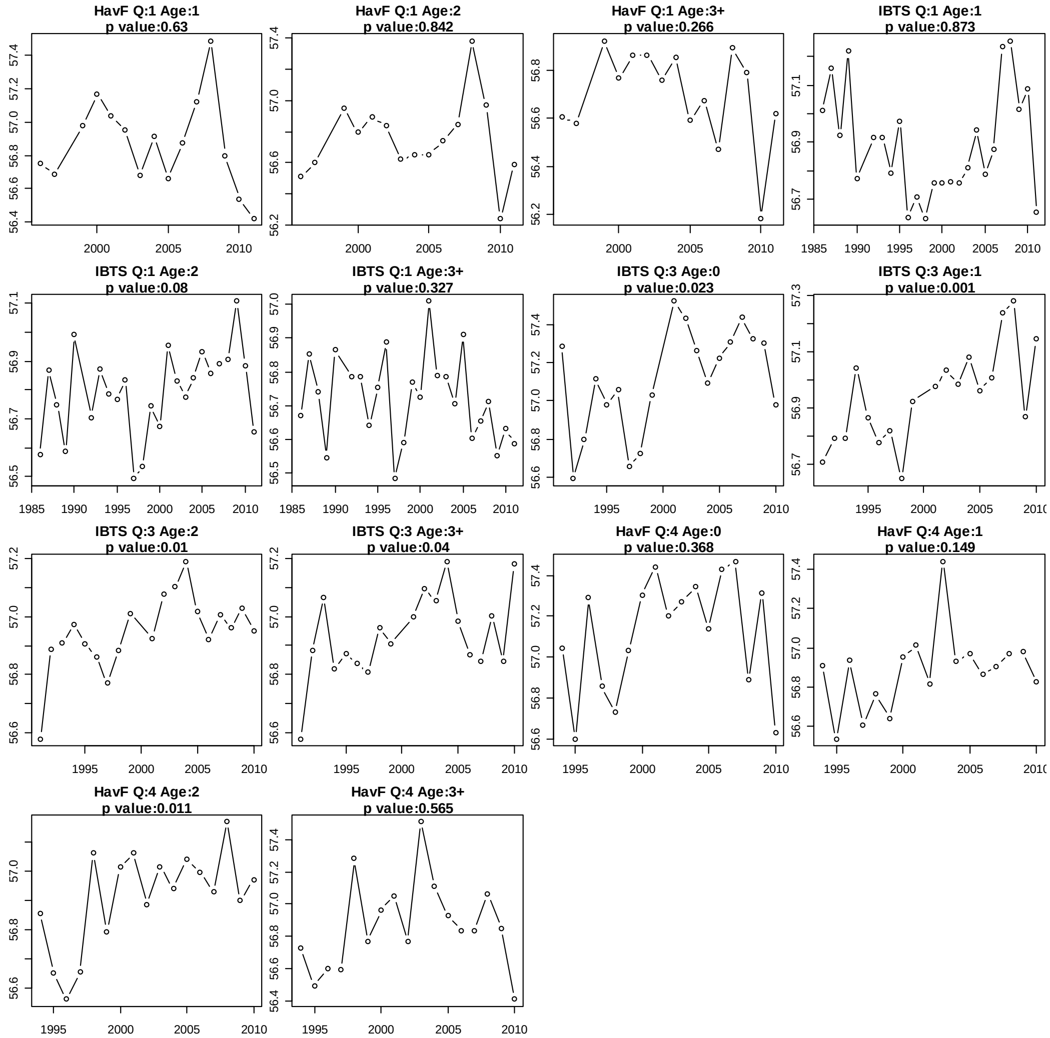



**Figure COG-6. Centre of gravity, latitude, by year survey and age. The "p value" expresses the significance level for the correlation between latitude and year. The centre by year represents the weighted average of haul positions, weighted by CPUE.**

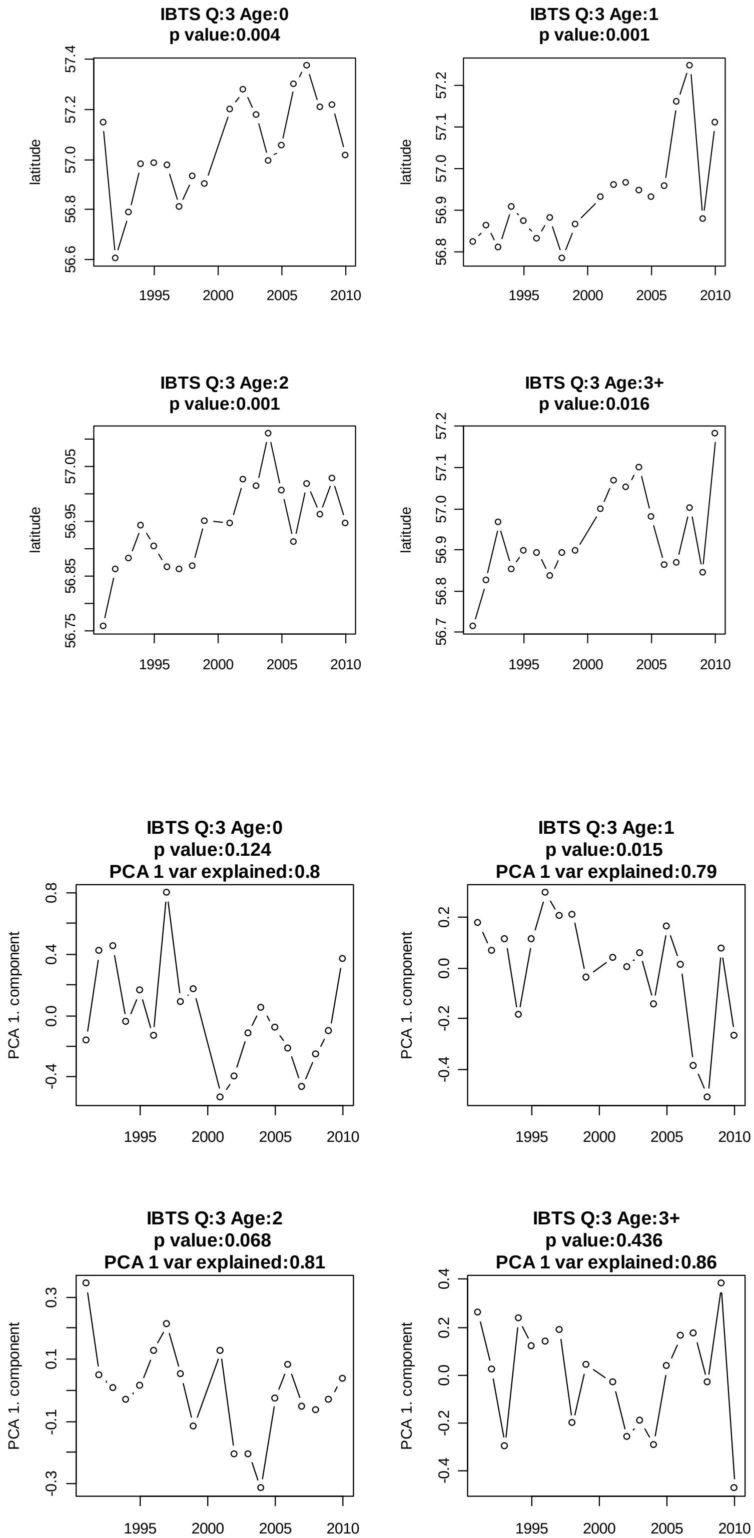



**Figure COG-7. Centre of gravity IBTS quarter 3. The centre by year represents the weighted average of haul positions, weighted by log CPUE+1).Upper 4 figures show the latitude of the gravity by year, the lower 4 figures show the first PCA scores. The "p value" expresses the significance level for the correlation between latitude and year.**

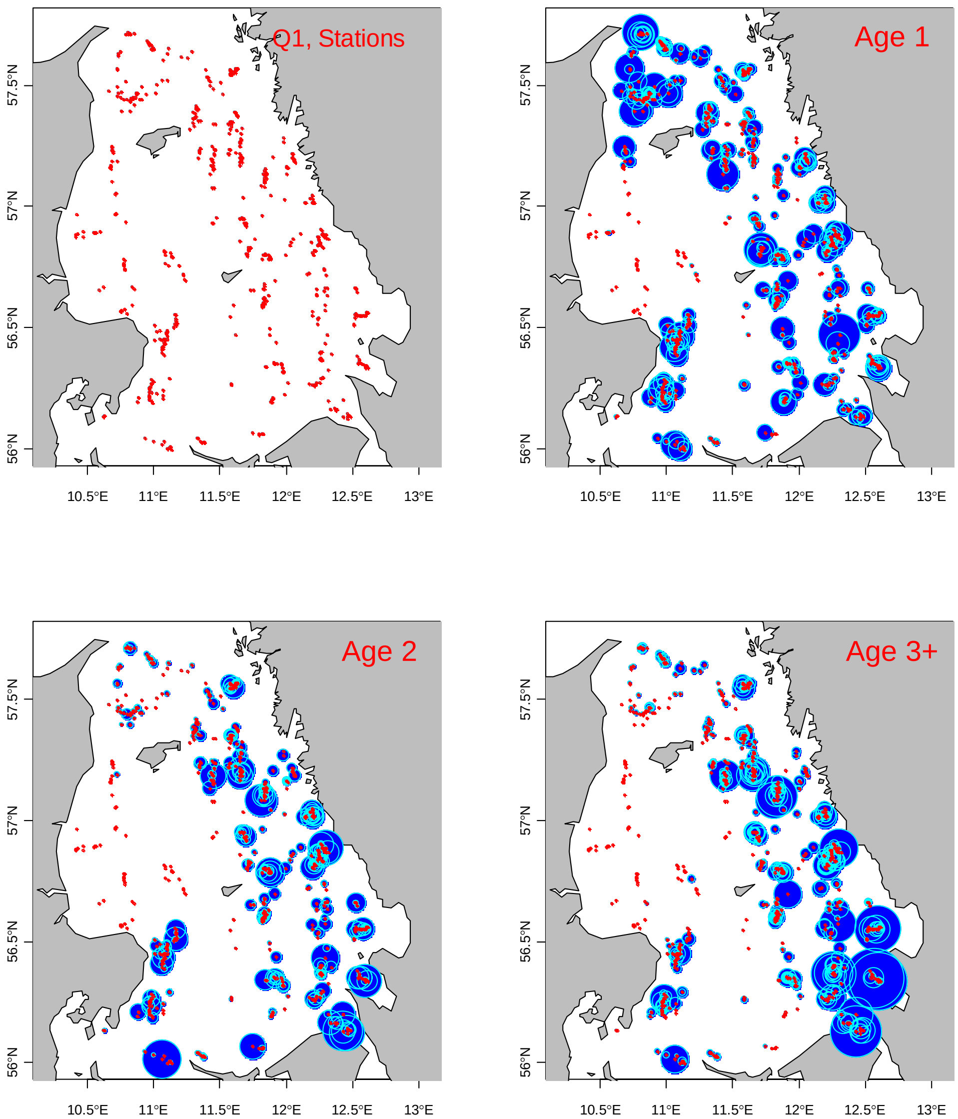



**Figure ANA-1. Distribution of trawl station (red points) and CPUE at age by station from Quarter 1, IBTS and Havfisken surveys, 1996-2011. The area of the blue dots is proportional to CPUE. The scaling of CPUE~dot size is different between ages.**

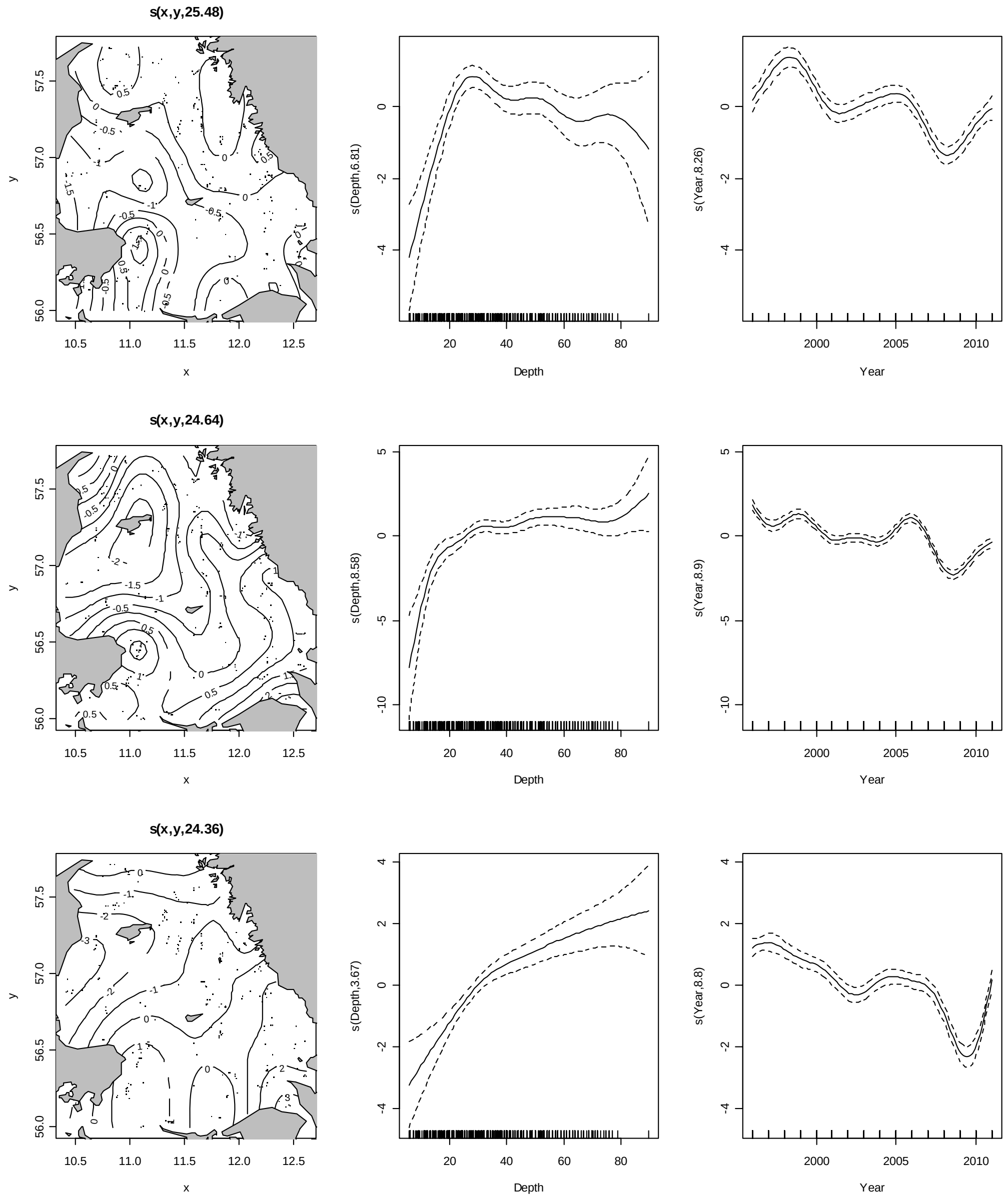



**Figure ANA-2. Plots of predicted effect of position (latitude, longitude), depth and year as estimated by GAM models on CPUE (number) at age in Quarter 1 surveys. Top row presents results for age 1, second row for age 2 and bottom row for age 3+. For depth and year effect, the mean value and 95% confidence interval are shown.**

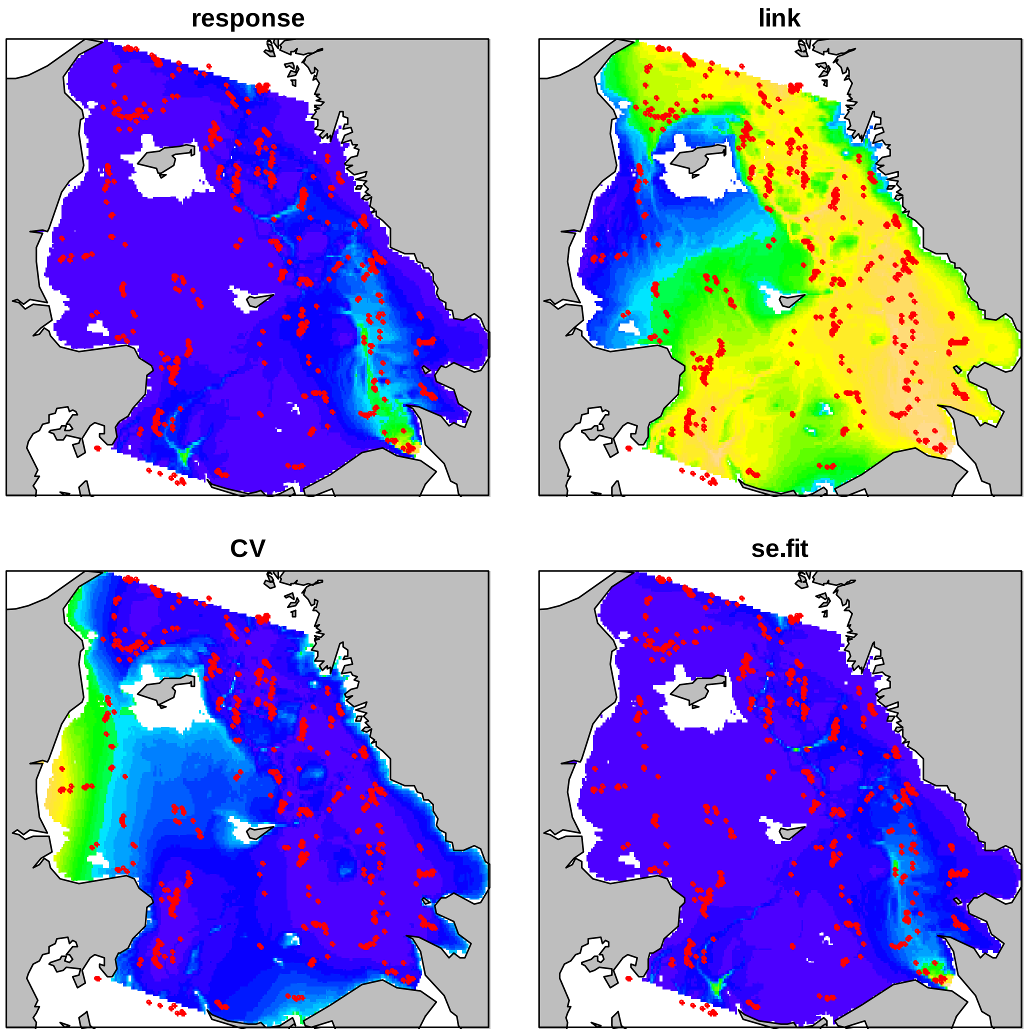



**Figure ANA-3. Predicted stock distribution and uncertainties, quarter 1. Age 3 plus. "Response" is the predicted value, "link" is the log (linked) value, CV is the coefficient of variation and se.fit is the standard deviation of the predicted value. Blue show low value, green medium and yellow – orange the highest values. White areas are outside the Kattegat or on depth less than 5 m.**

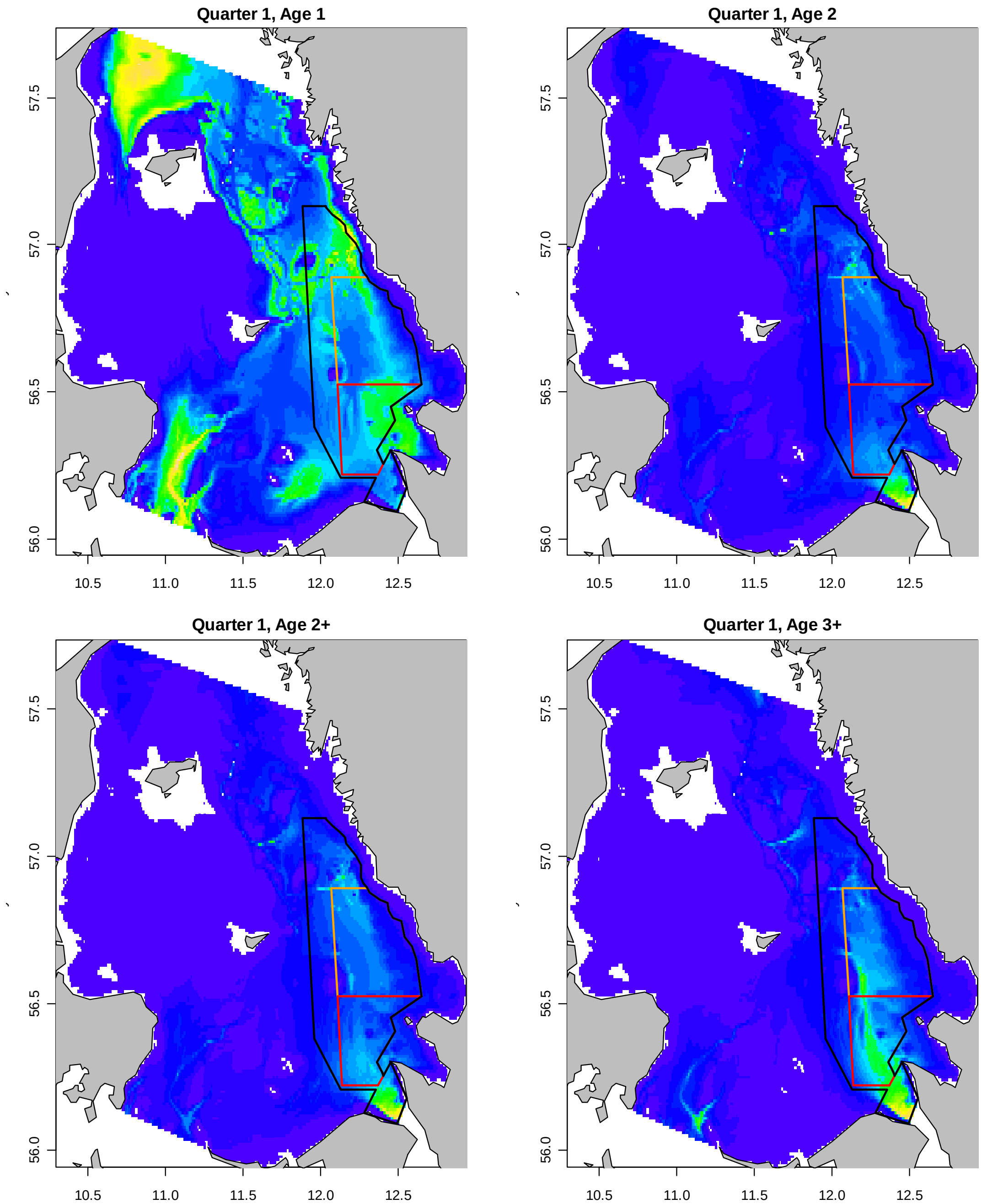



**Figure ANA-4. Predicted stock distribution, quarter 1. Blue show low density, green medium and yellow – orange the highest densities. White areas are outside the Kattegat or on depth less than 5 m.**

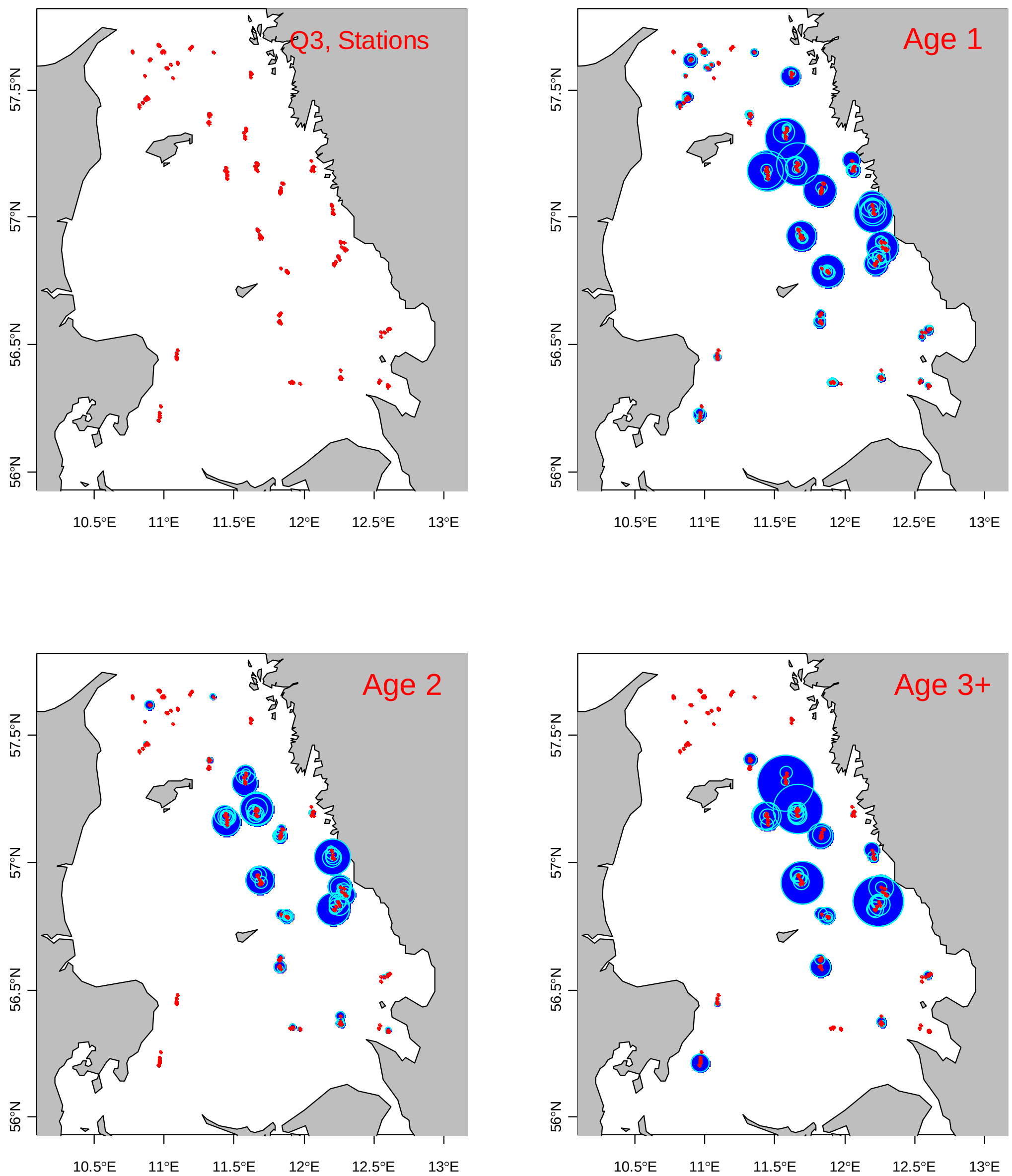



**Figure ANA-5. Distribution of trawl station (red points) and CPUE at age by station from Quarter 3, IBTS, 2001-2010. The area of the blue dots is proportional to CPUE. The scaling of CPUE~dot size is different between ages.**

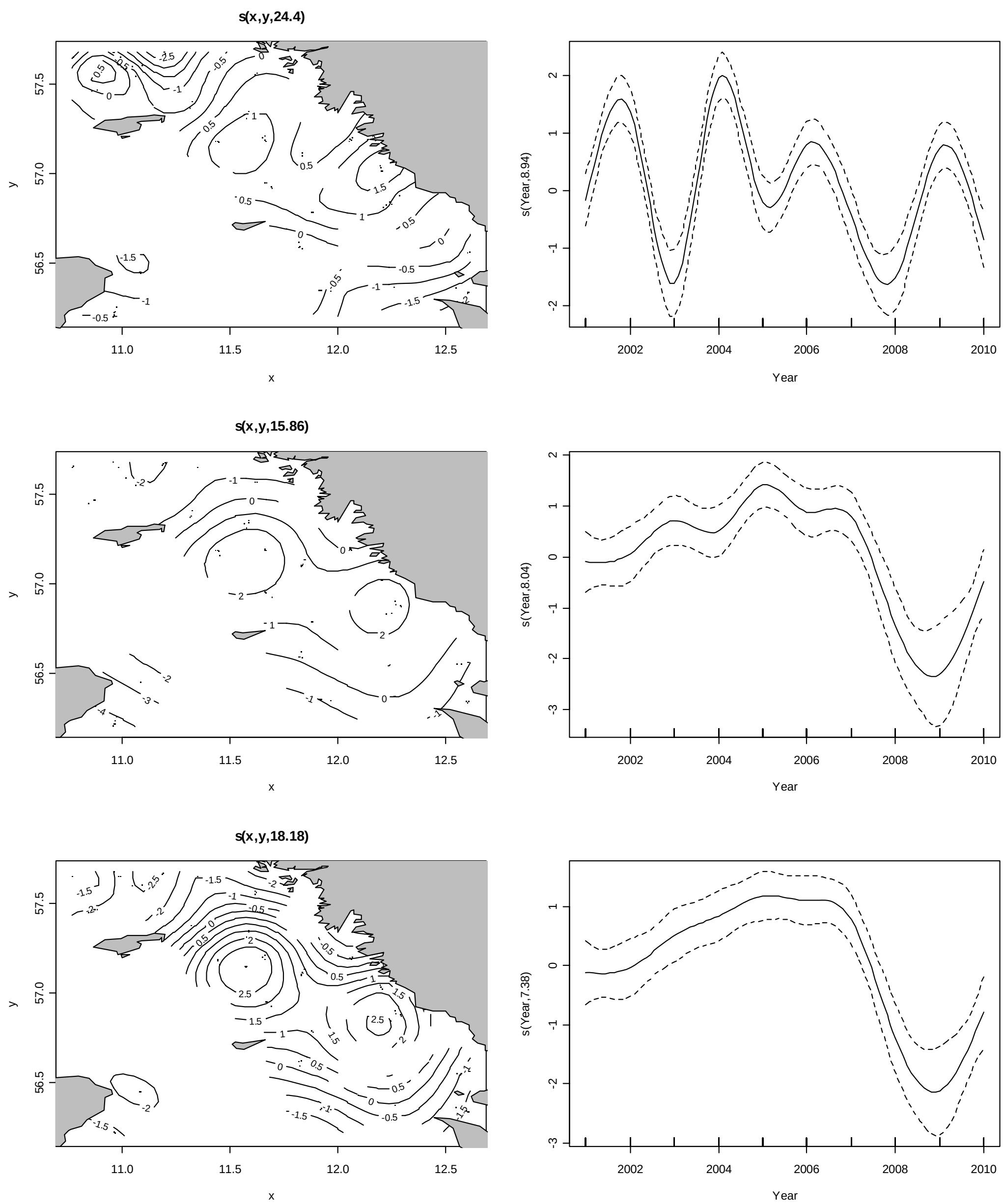



**Figure ANA-6. Plots of predicted effect of position (latitude, longitude), depth and year as estimated by GAM models on CPUE (number) at age in Quarter 3 survey. Top row presents results for age 1, second row for age 2 and bottom row for age 2+. For depth and year effect, the mean value and 95% confidence interval are shown.**

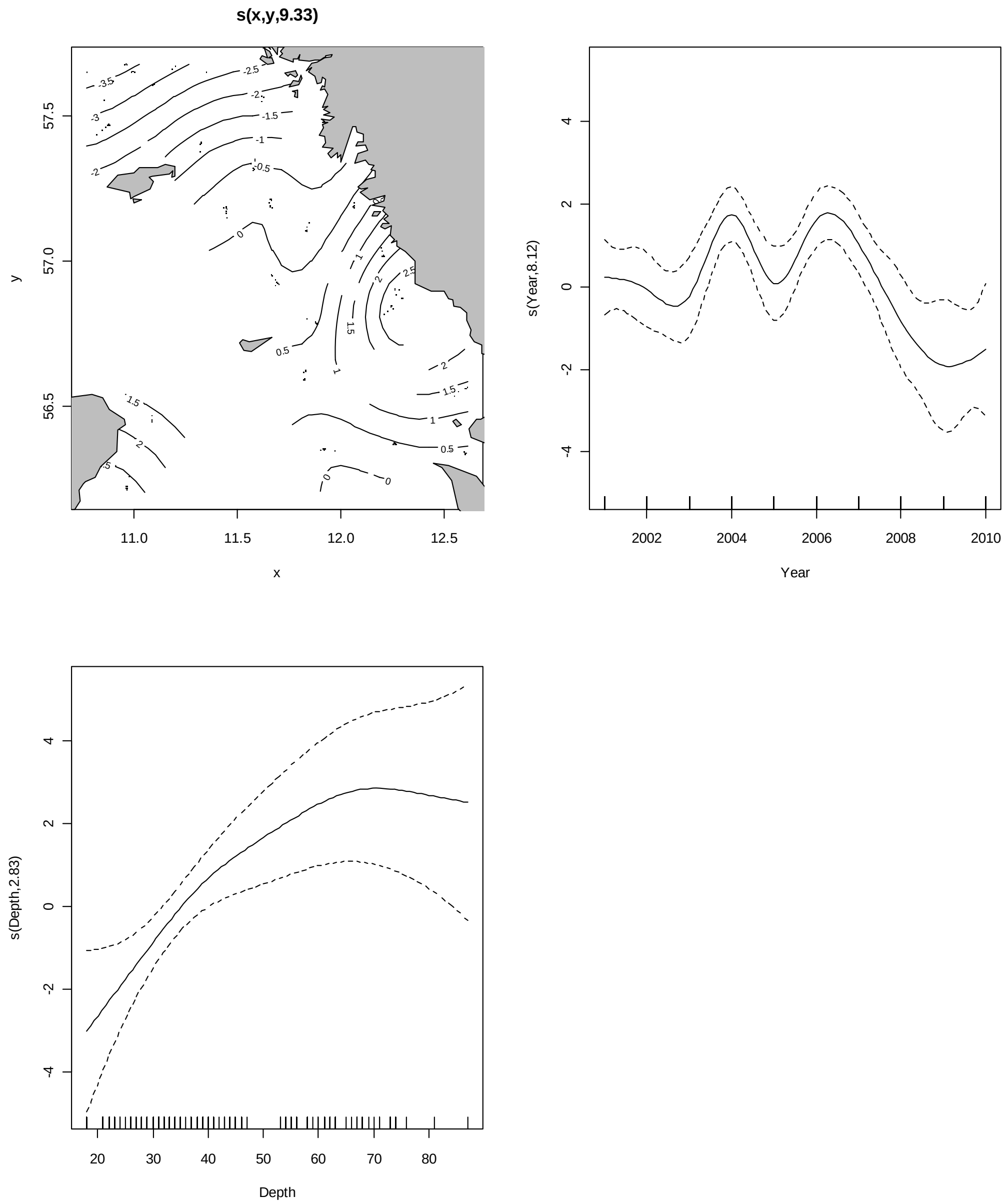



**Figure ANA-6 (continued) Plots of predicted effect of position (latitude, longitude), depth and year as estimated by GAM models on CPUE (number) at age in Quarter 3 survey, age 3+. For depth and year effect, the mean value and 95% confidence interval are shown.**

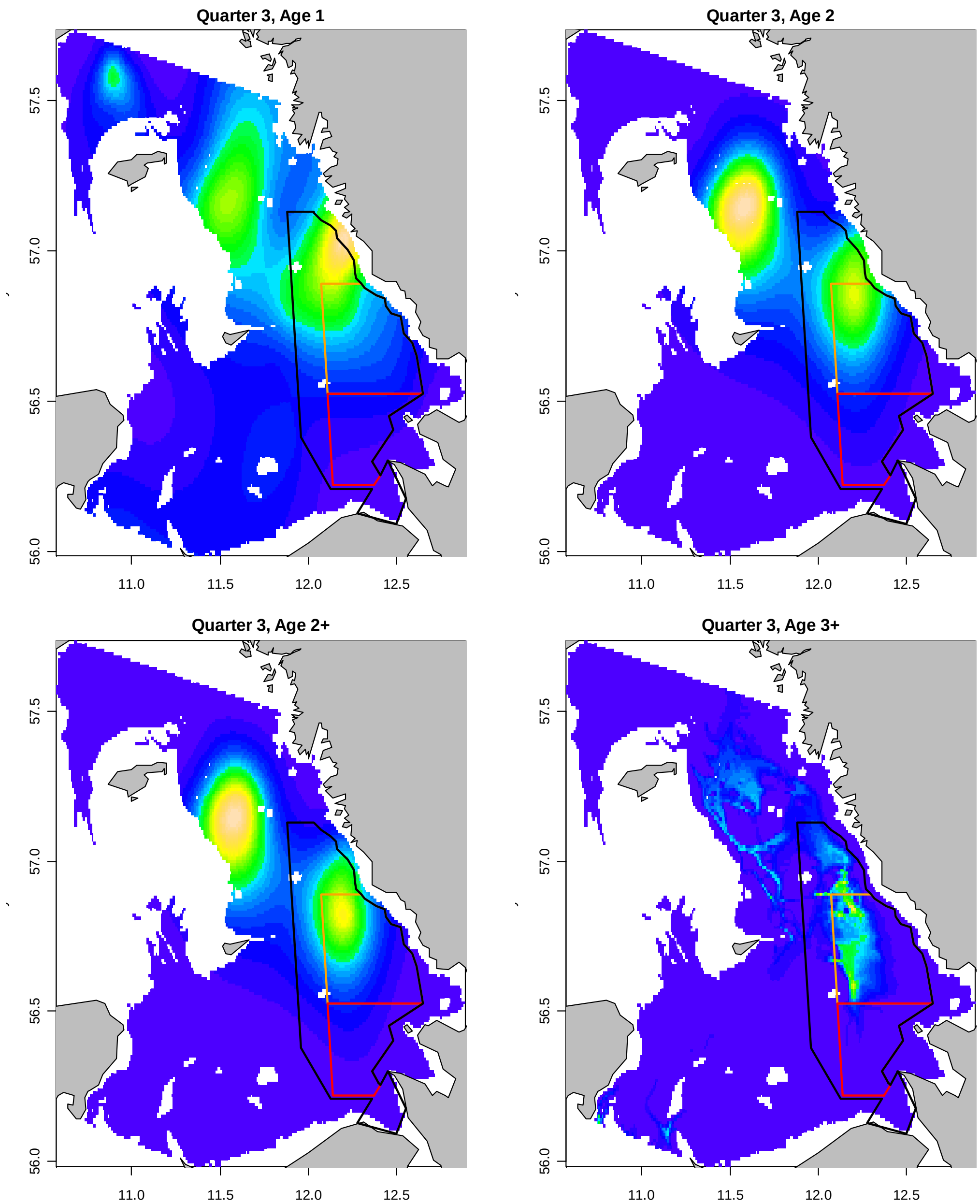



**Figure ANA-7. Predicted stock distribution, quarter 3. Blue show low density, green medium and yellow – orange the highest densities. White areas are outside the Kattegat or on depth less than 15 m.**

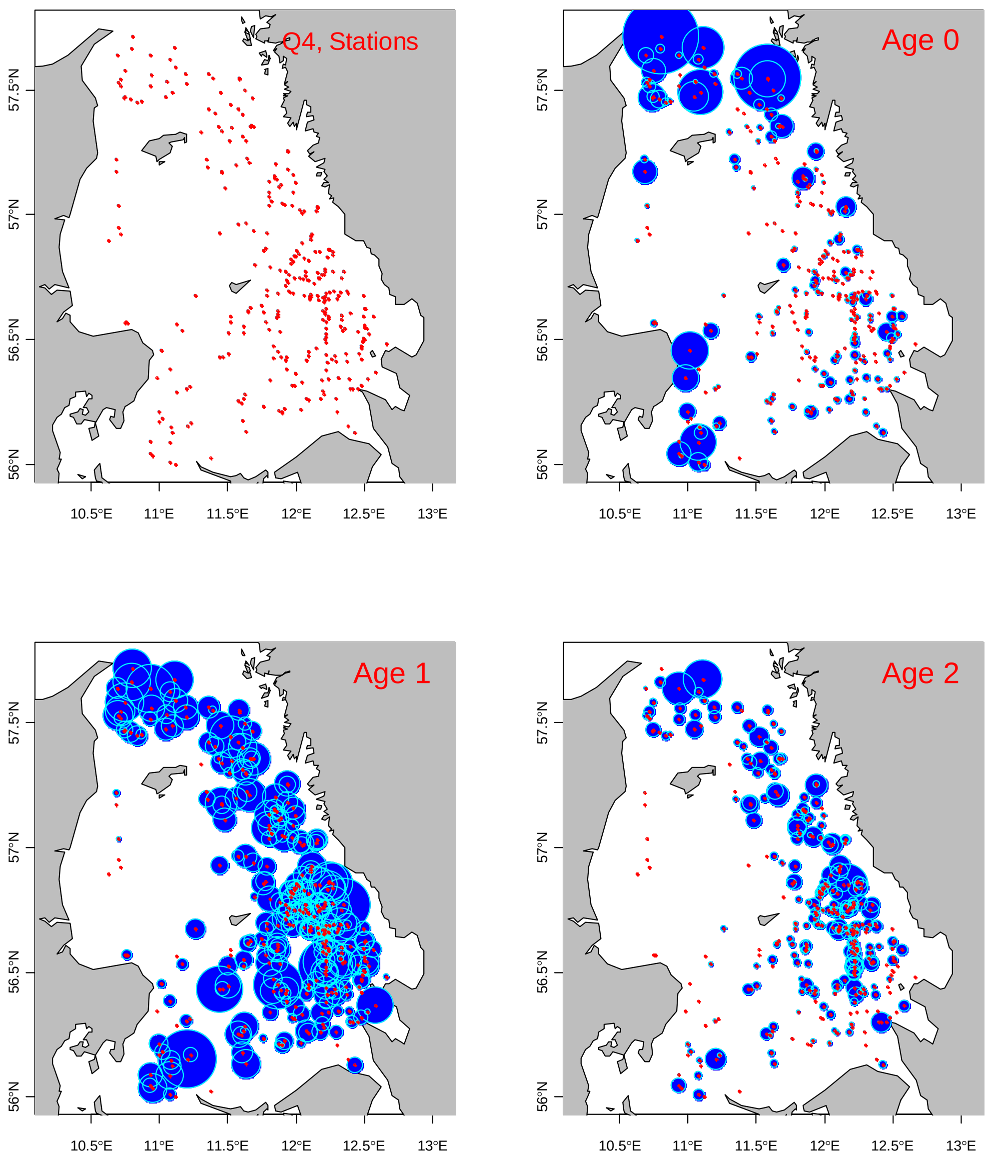



**Figure ANA-8. Distribution of trawl station (red points) and CPUE at age by station from Quarter 4,, Danish-Swedish cod survey and Havfisken survey, 2008-2010. The area of the blue dots is proportional to CPUE. The scaling of CPUE~dot size is different between ages.**

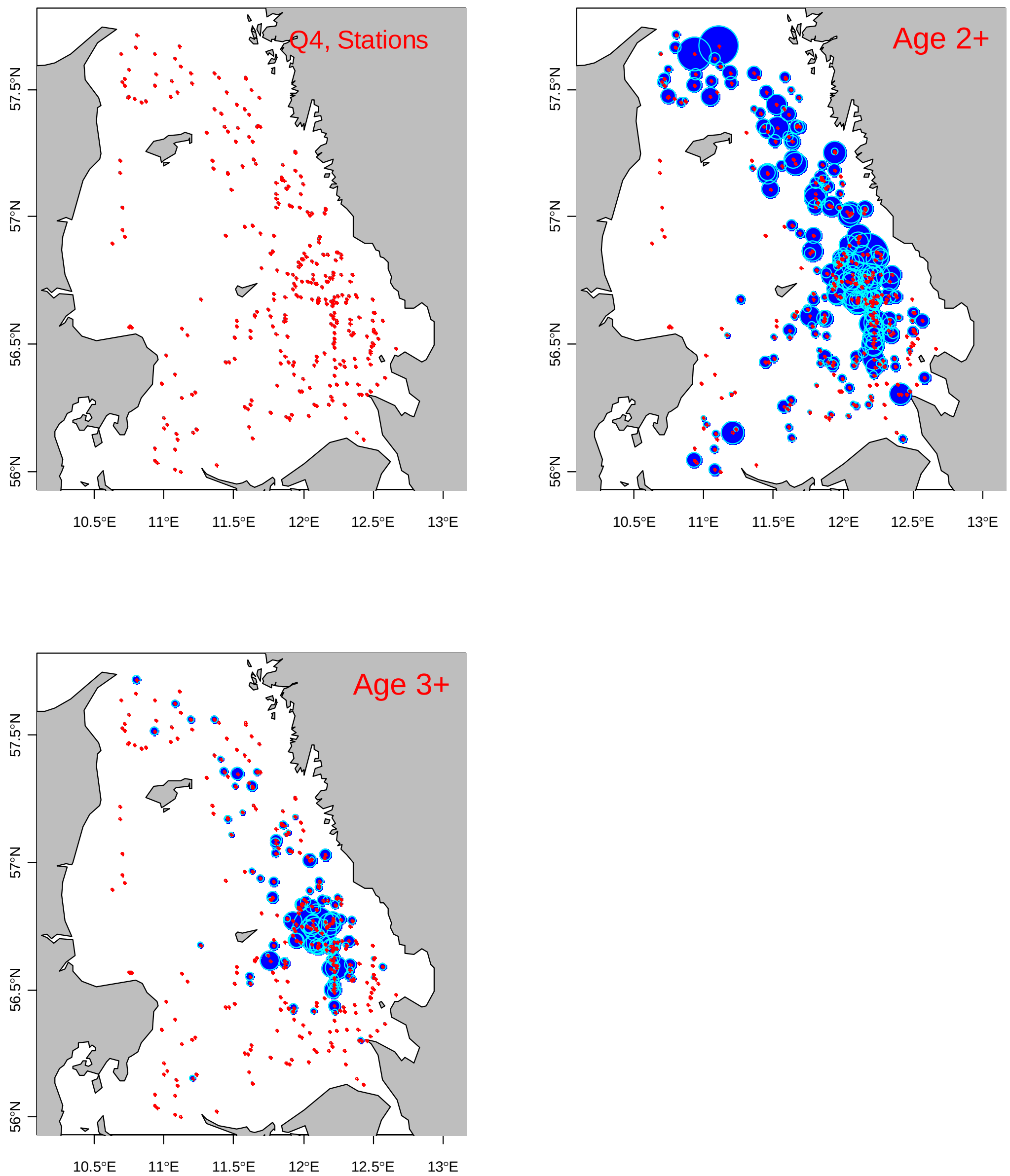



**Figure ANA-9. Distribution of trawl station (red points) and CPUE at age by station from Quarter 4, 2008-2010, Danish-Swedish cod survey and Havfisken survey. The area of the blue dots is proportional to CPUE. The scaling of CPUE~dot size is different between ages.**

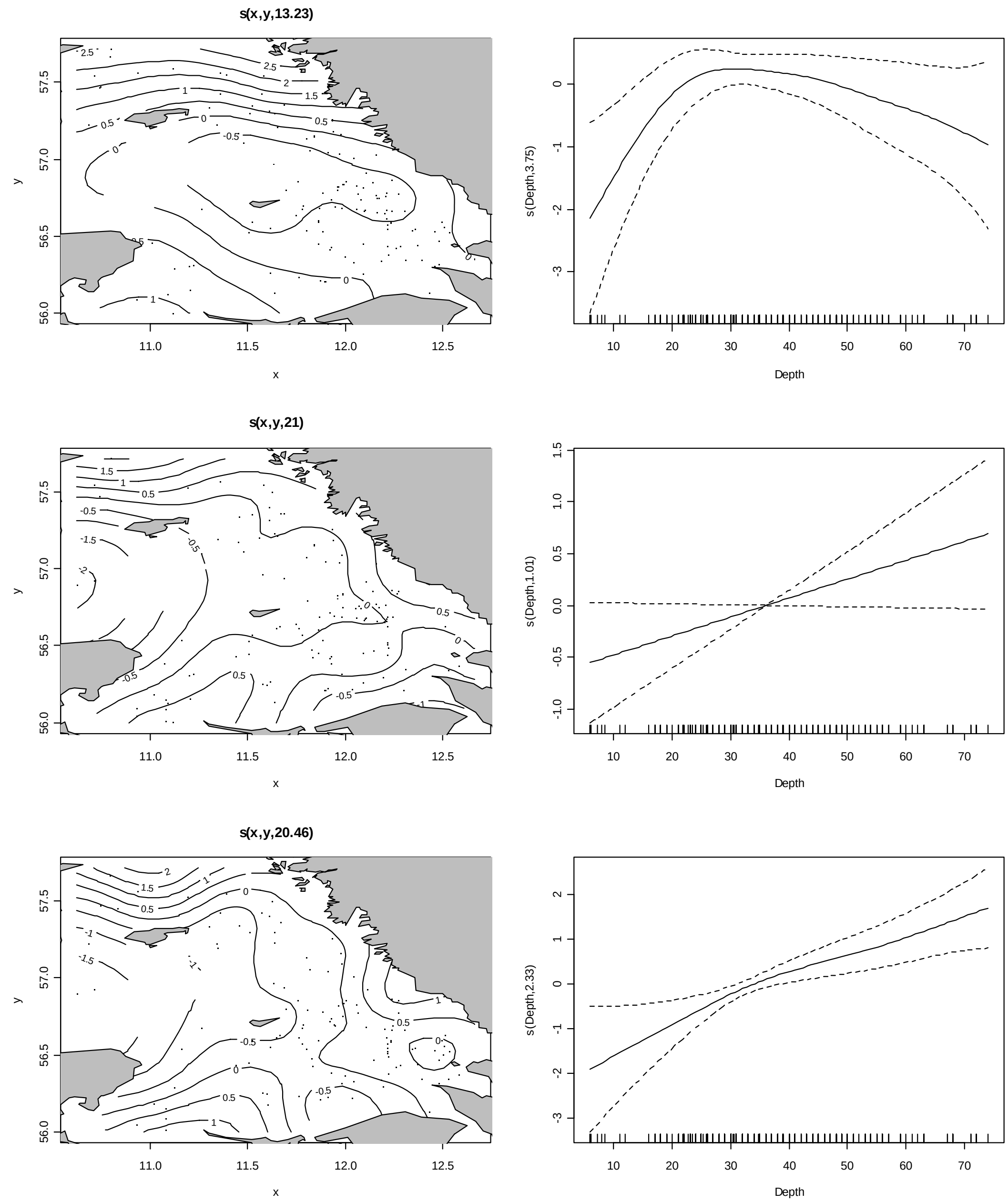



**Figure ANA-10. Plots of predicted effect of position (latitude, longitude), depth and year as estimated by GAM models on CPUE (number) at age in Quarter 4 survey, age 0 (top), age 1 and age 2 (bottom row). For depth and year effect, the mean value and 95% confidence interval are shown.**

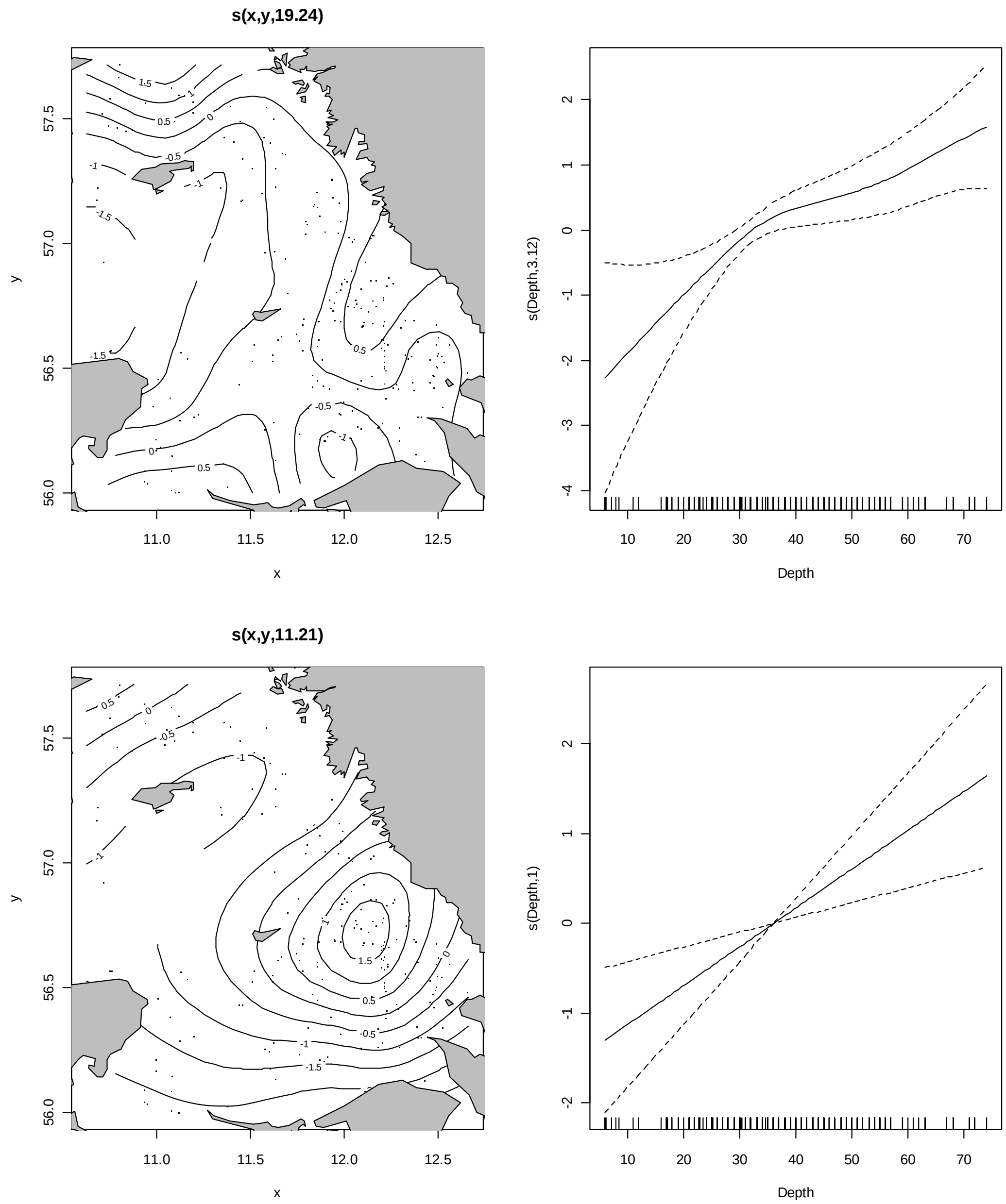



**Figure ANA-10 (continued). Plots of predicted effect of position (latitude, longitude), depth and year as estimated by GAM models on CPUE (number) at age in Quarter 4 survey, age 2+ (top) and age 3+ (bottom row). For depth effect, the mean value and 95% confidence interval are shown.**

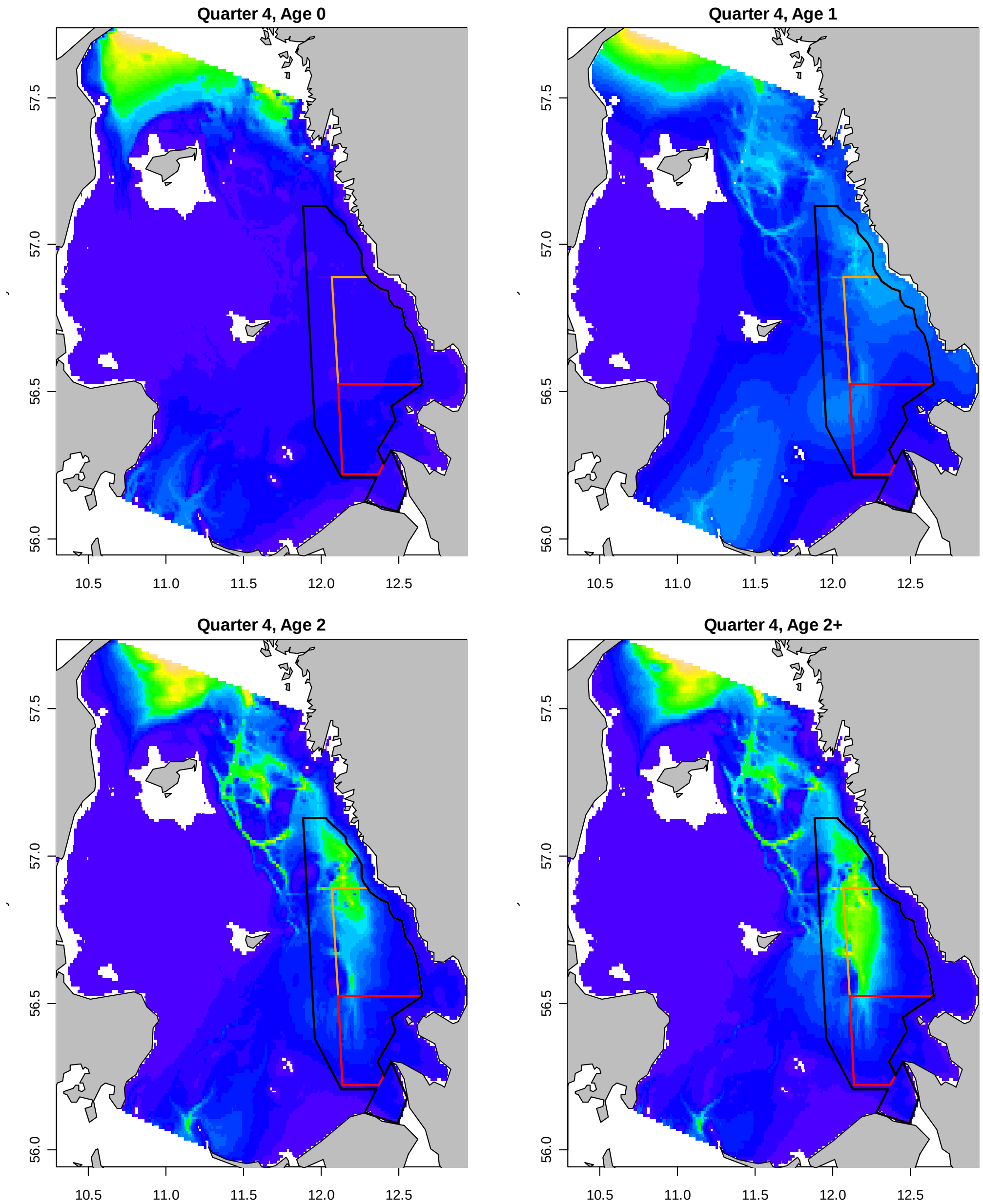



**Figure ANA-11. Predicted stock distribution, quarter 4. Blue show low density, green medium and yellow – orange the highest densities. White areas are outside the Kattegat or on depth less than 5 m.**

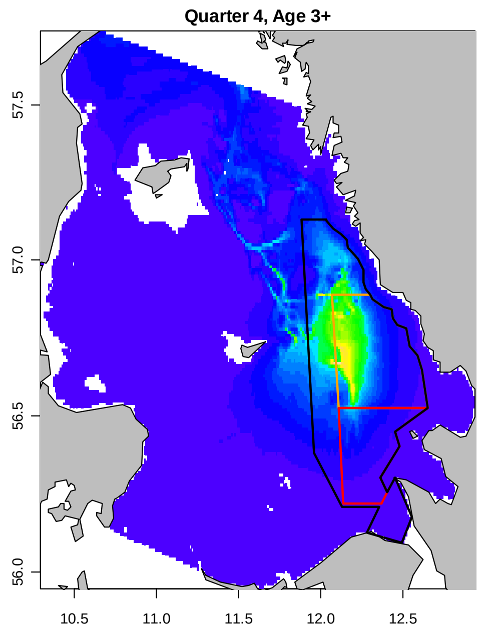



**Figure ANA-11 (continued). Predicted stock distribution, quarter 4. Blue show low density, green medium and yellow – orange the highest densities. White areas are outside the Kattegat or on depth less than 5 m.**

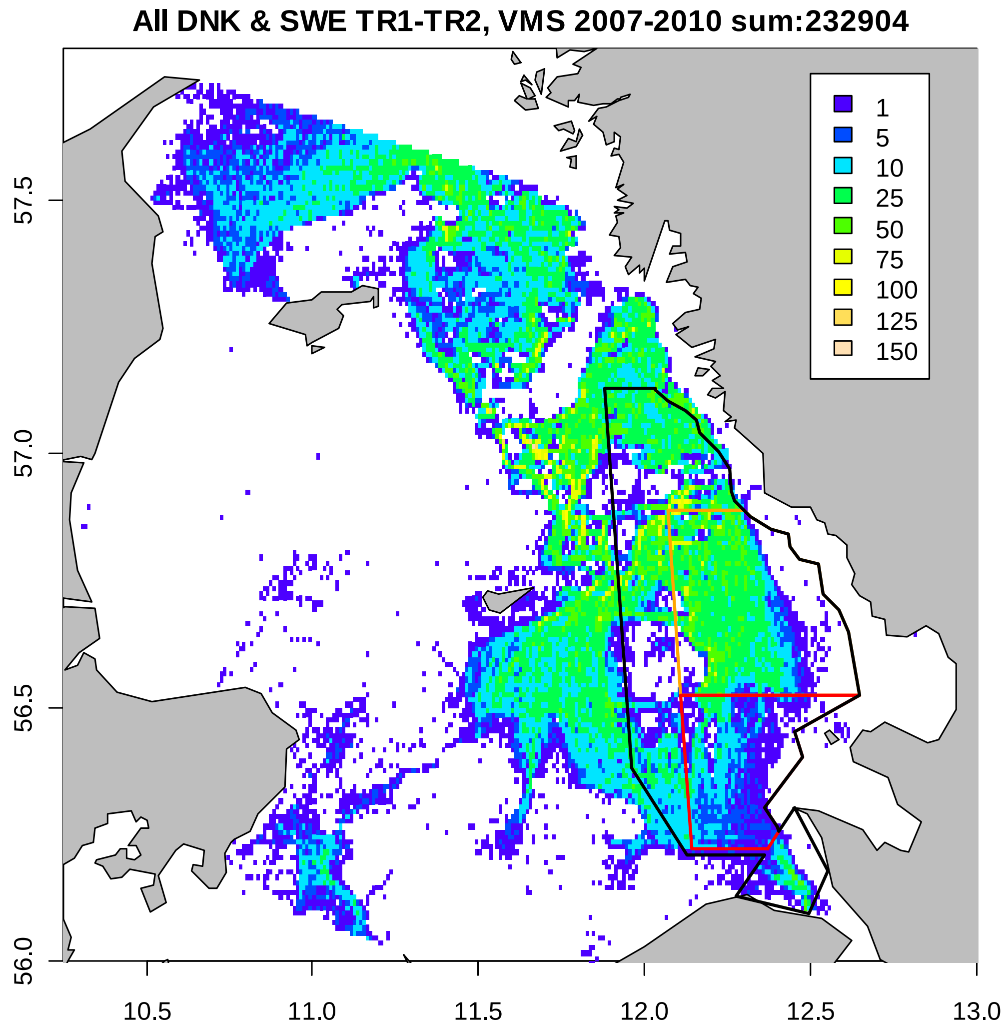



**Figure VMS 1. Distribution fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) for segment TR1 and TR2, Danish and Swedish data combined. Resolution 0.01 degree.**

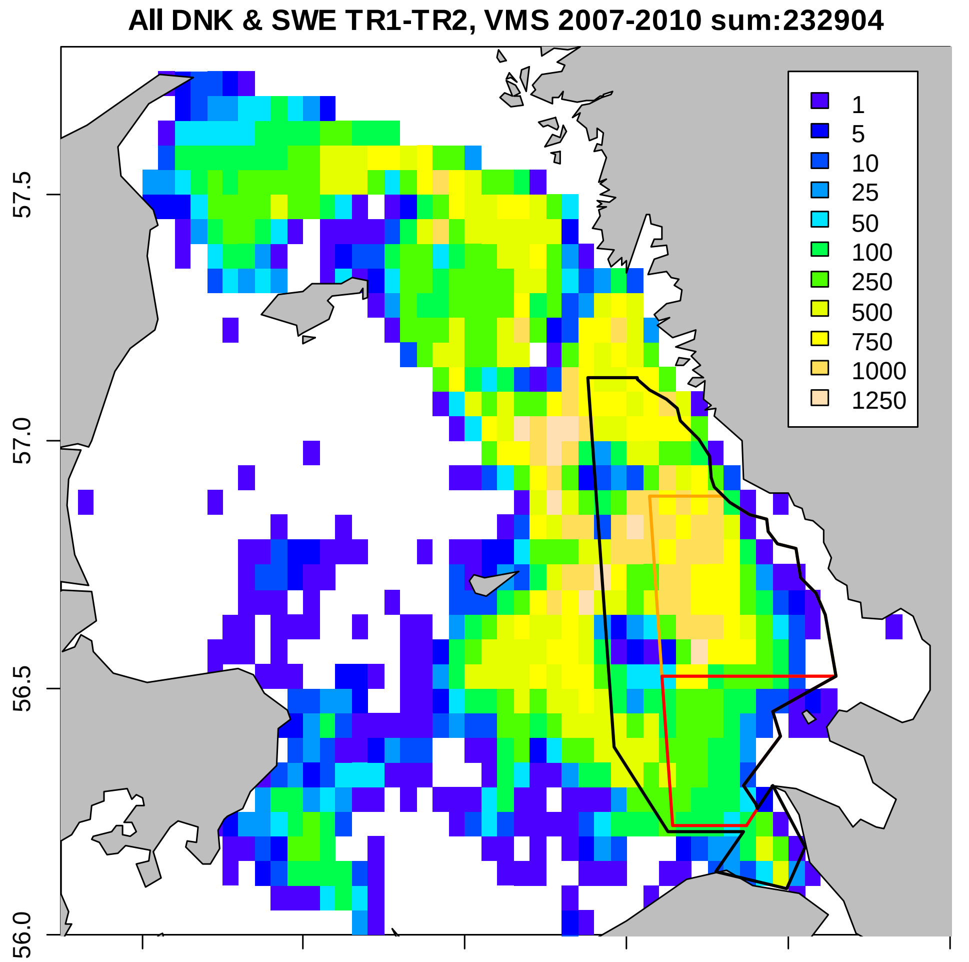



**Figure VMS-2. Distribution fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) for segment TR1 and TR2, Danish and Swedish data combined. Resolution 0.05 degree.**

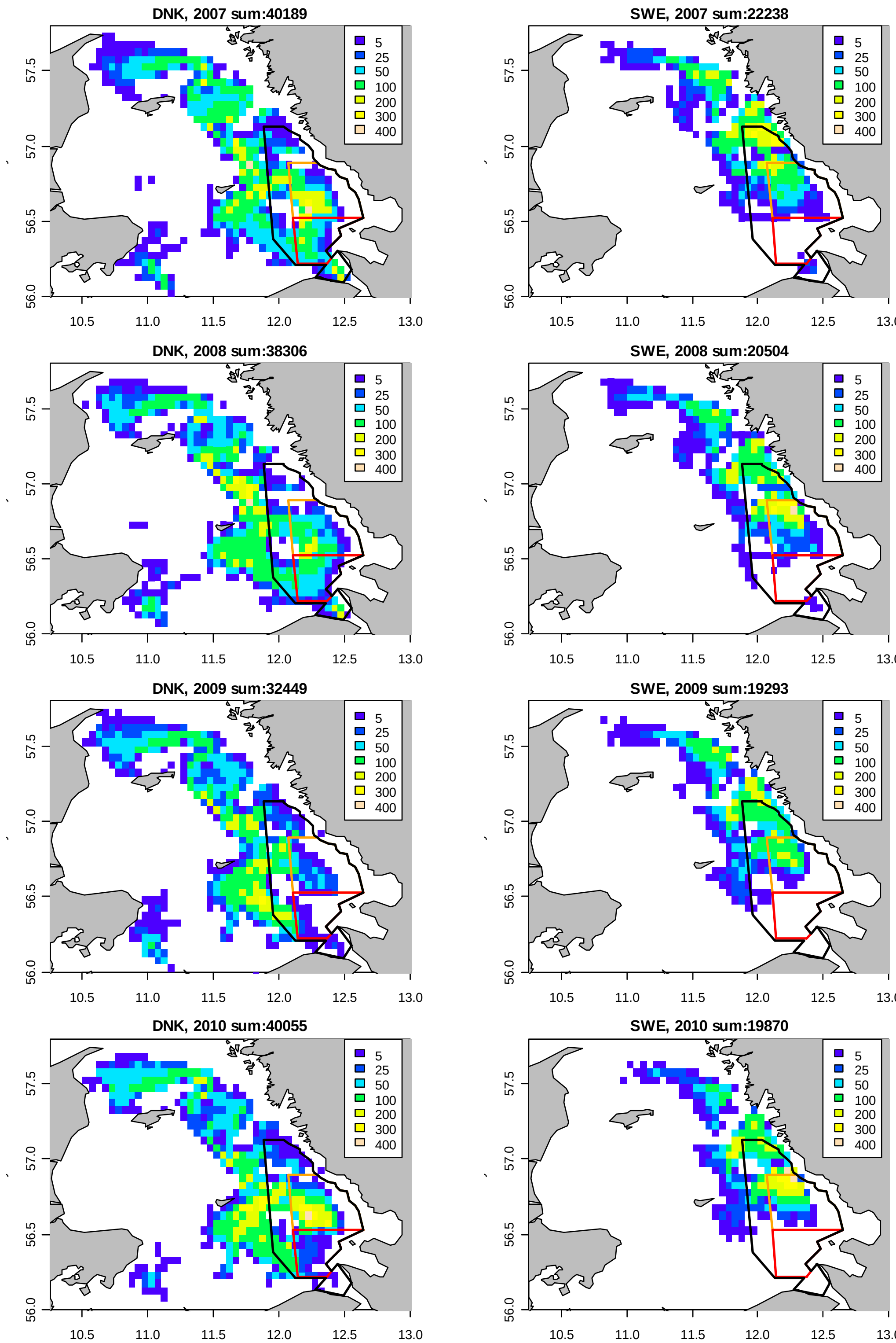



**Figure VMS-3. Distribution fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) by country and year for segment TR1 and TR2 combined**

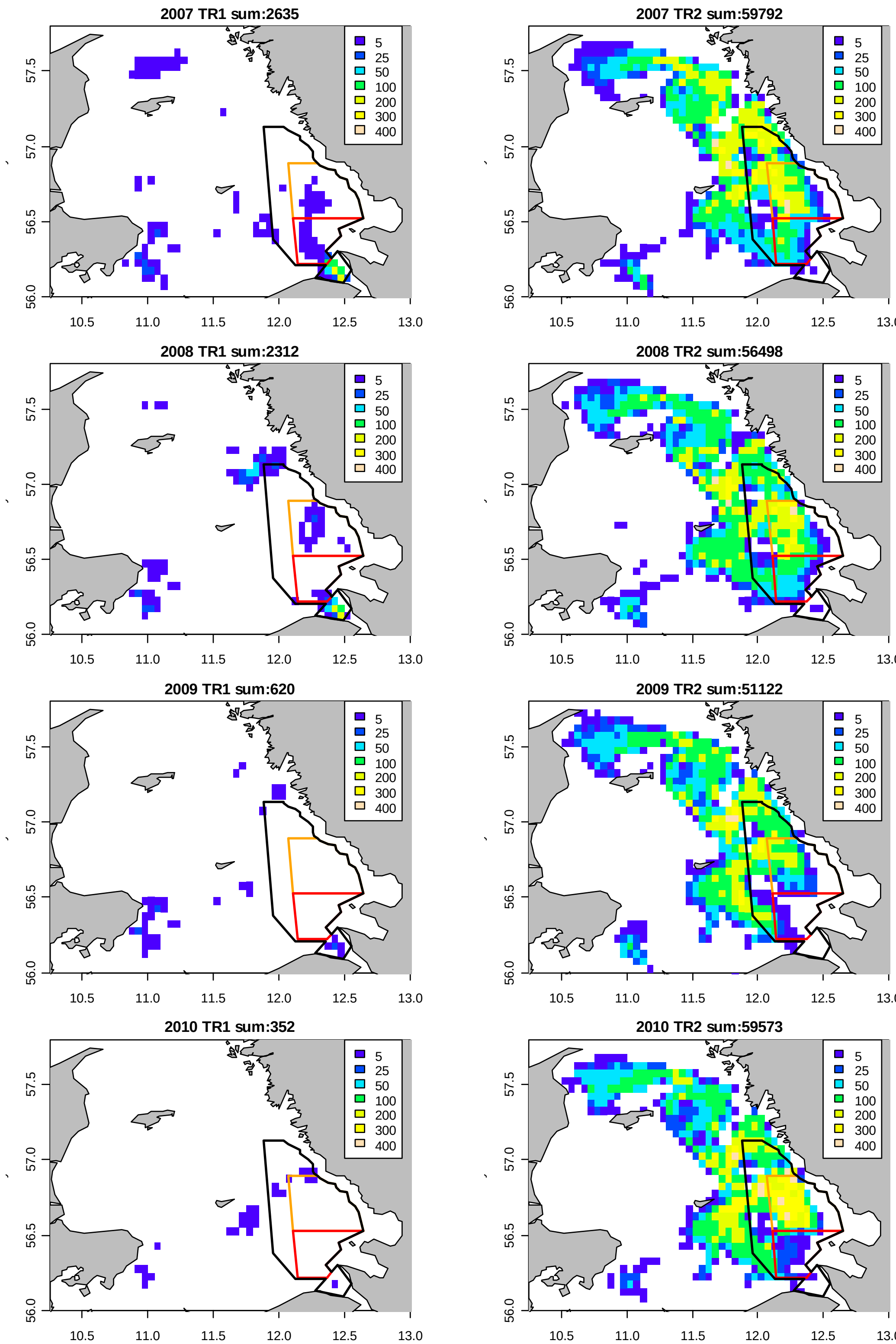



**Figure VMS-4. Distribution fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) by gear segment country and year, Danish and Swedish data combined**

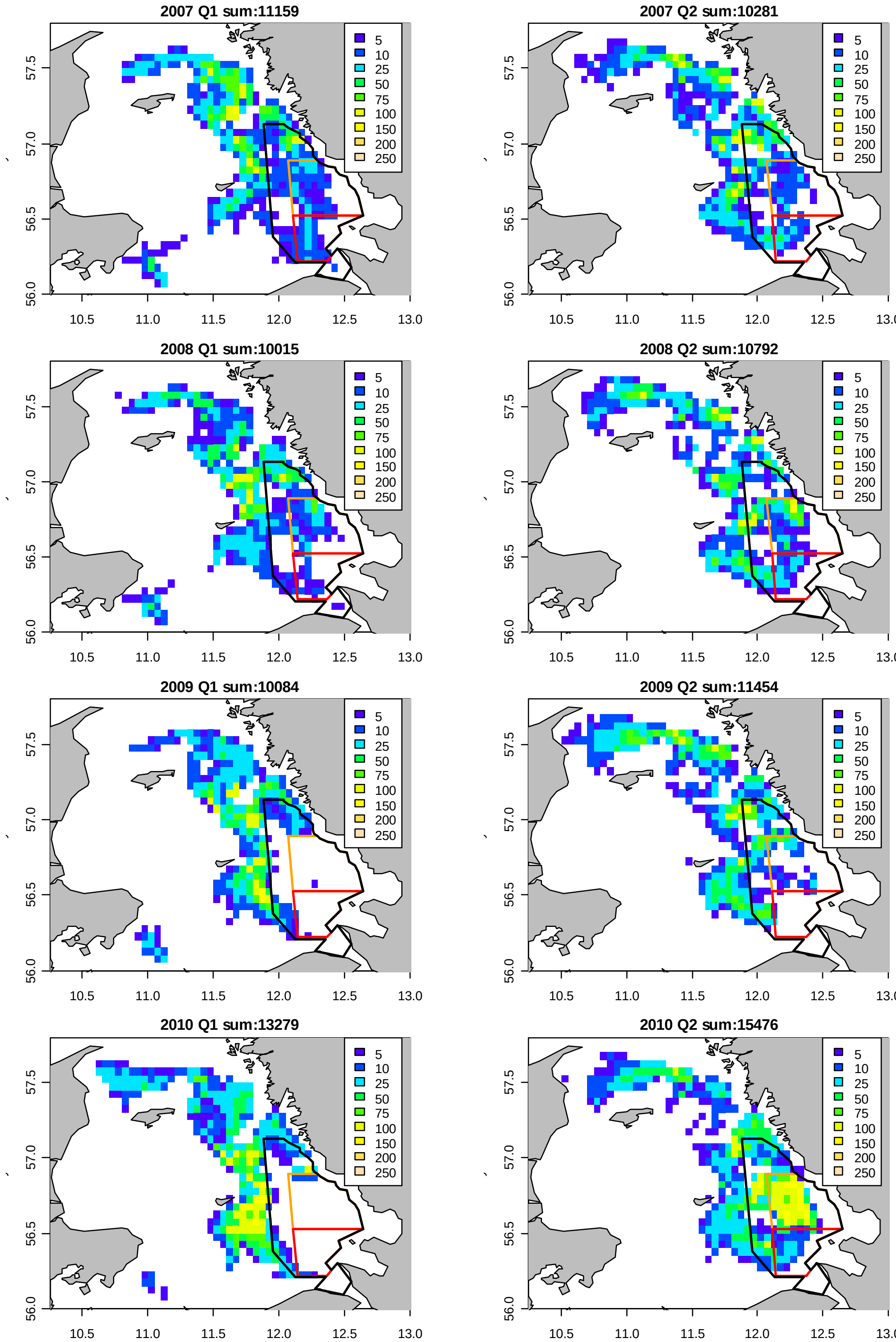



**Figure VMS-5. Distribution fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) for TR2 segment by year and quarter, Danish and Swedish data combined**

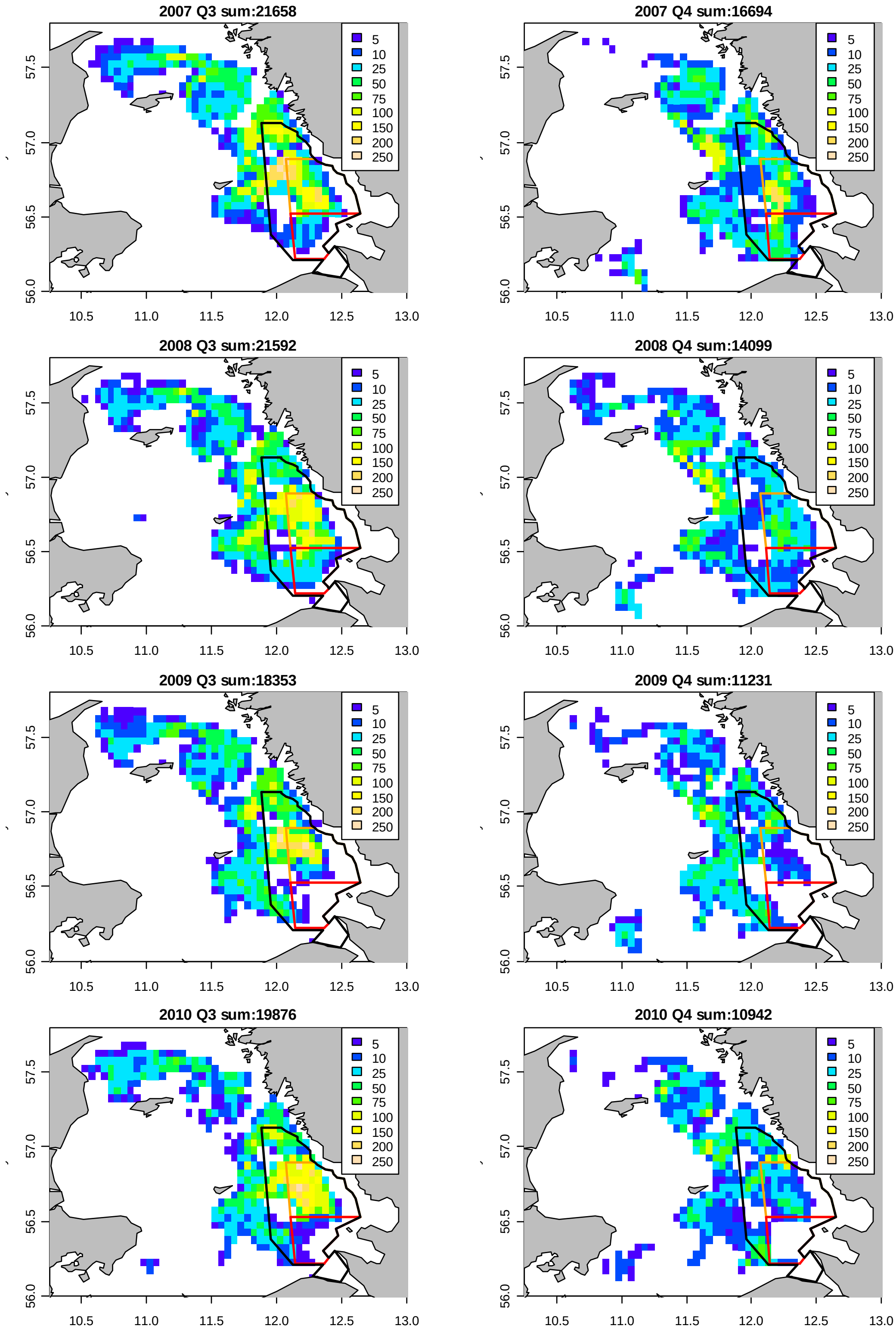



**Figure VMS-6. Distribution fishing effort (sum of  VMS hourly ping with vessel speed 2-4 knots) for TR2 segment by year and quarter, Danish and Swedish data combined**

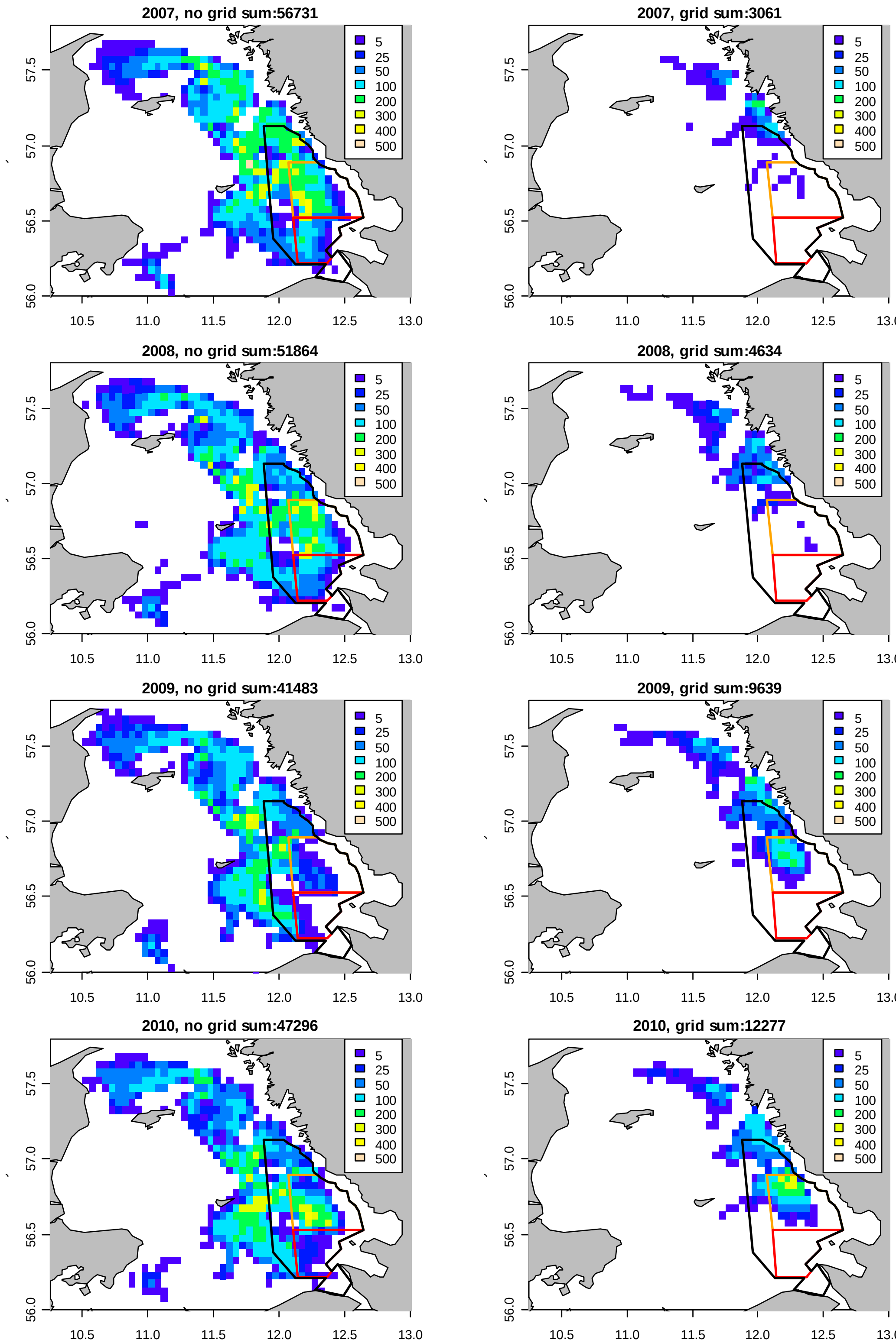



**Figure VMS-7. Distribution fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) for TR2 segment with and without the "Swedish sorting grid" by year and quarter, Danish and Swedish data combined.**

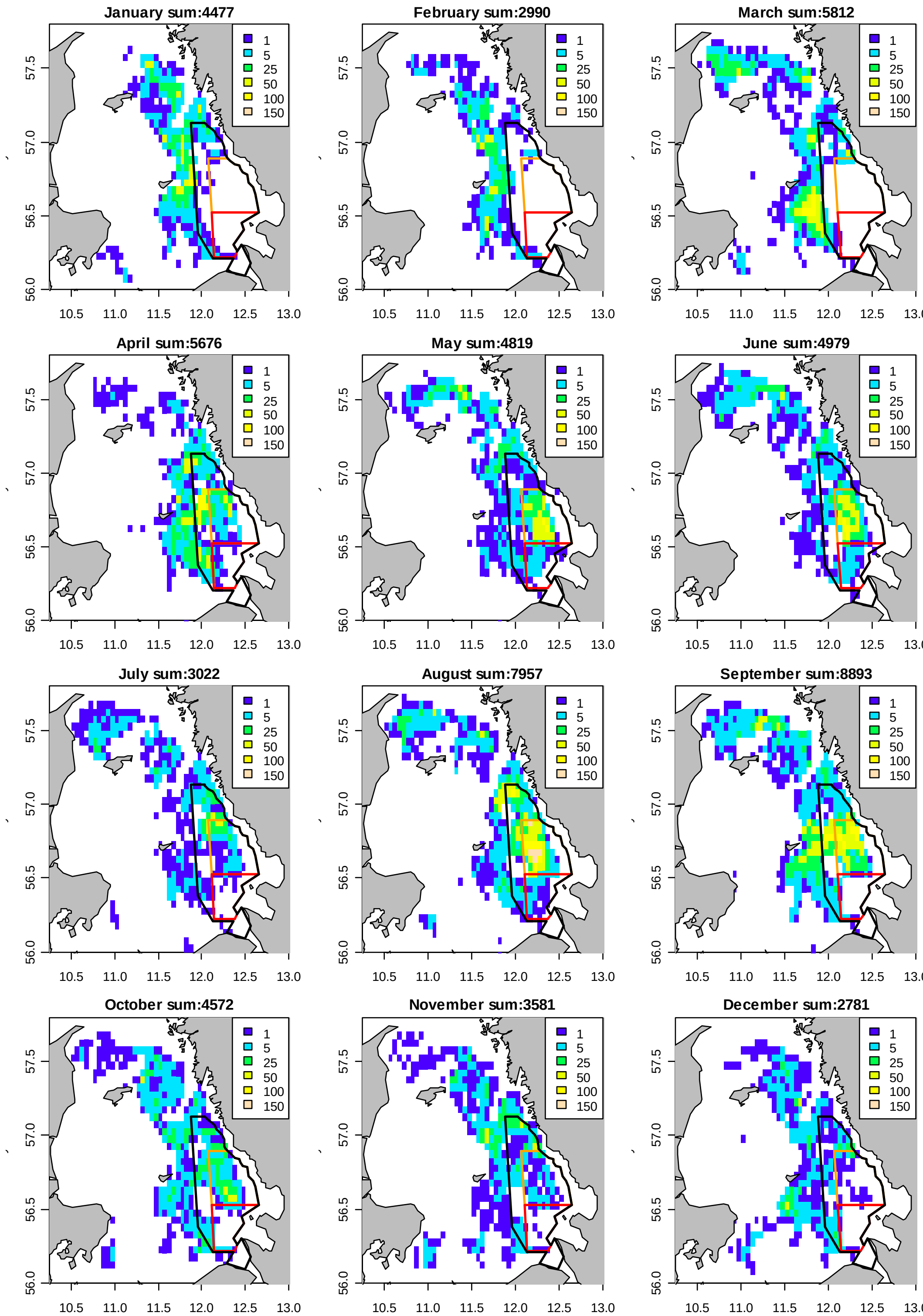



**Figure VMS-8a. Distribution monthly fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) for TR2 segment in 2010, Danish and Swedish data combined.**

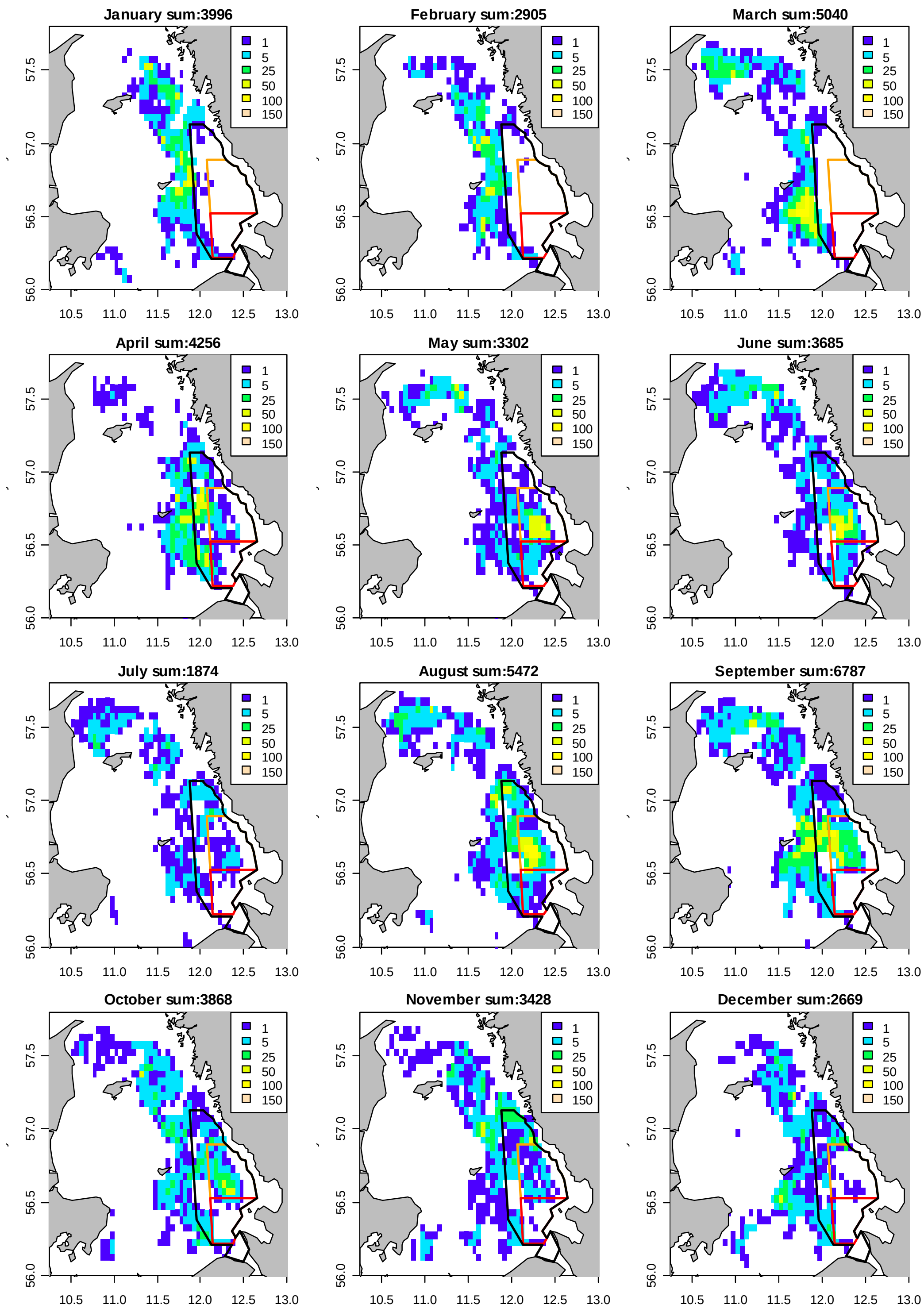



**Figure VMS-8b. Distribution monthly fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) for TR2 segment with no "Special Condition" in 2010, Danish and Swedish data combined.**

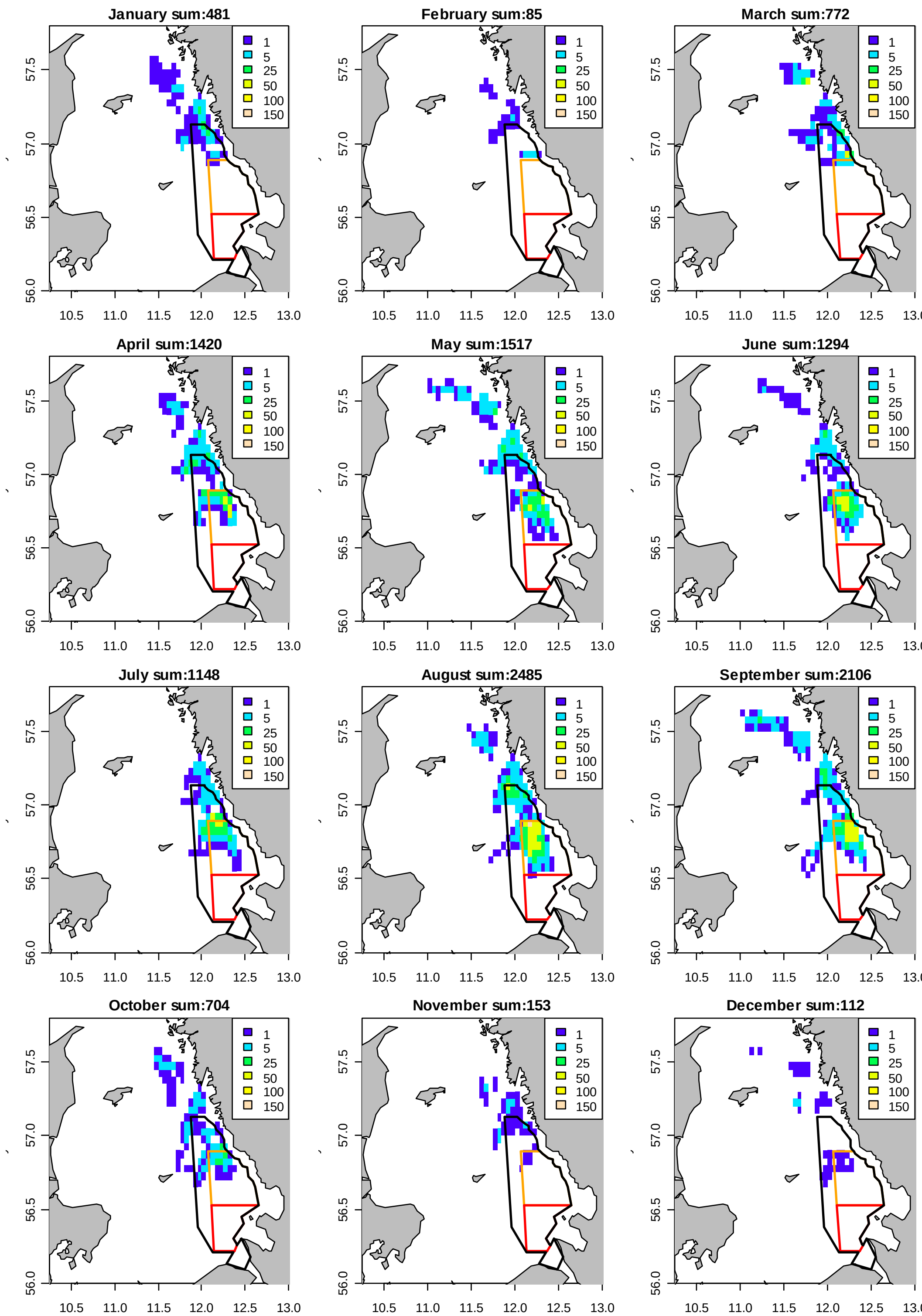



**Figure VMS-8c. Distribution monthly fishing effort (sum of VMS hourly ping with vessel speed 2-4 knots) for TR2 segment with "Special Condition" (Swedish sorting grid) in 2010, Danish and Swedish data combined.**


**Figure VMS-9. Centre of gravity by year and quarter for the Danish and Swedish TR2 VMS records. The gravity centre is the weighted (by number of VMS records) average position of the VMS records.**

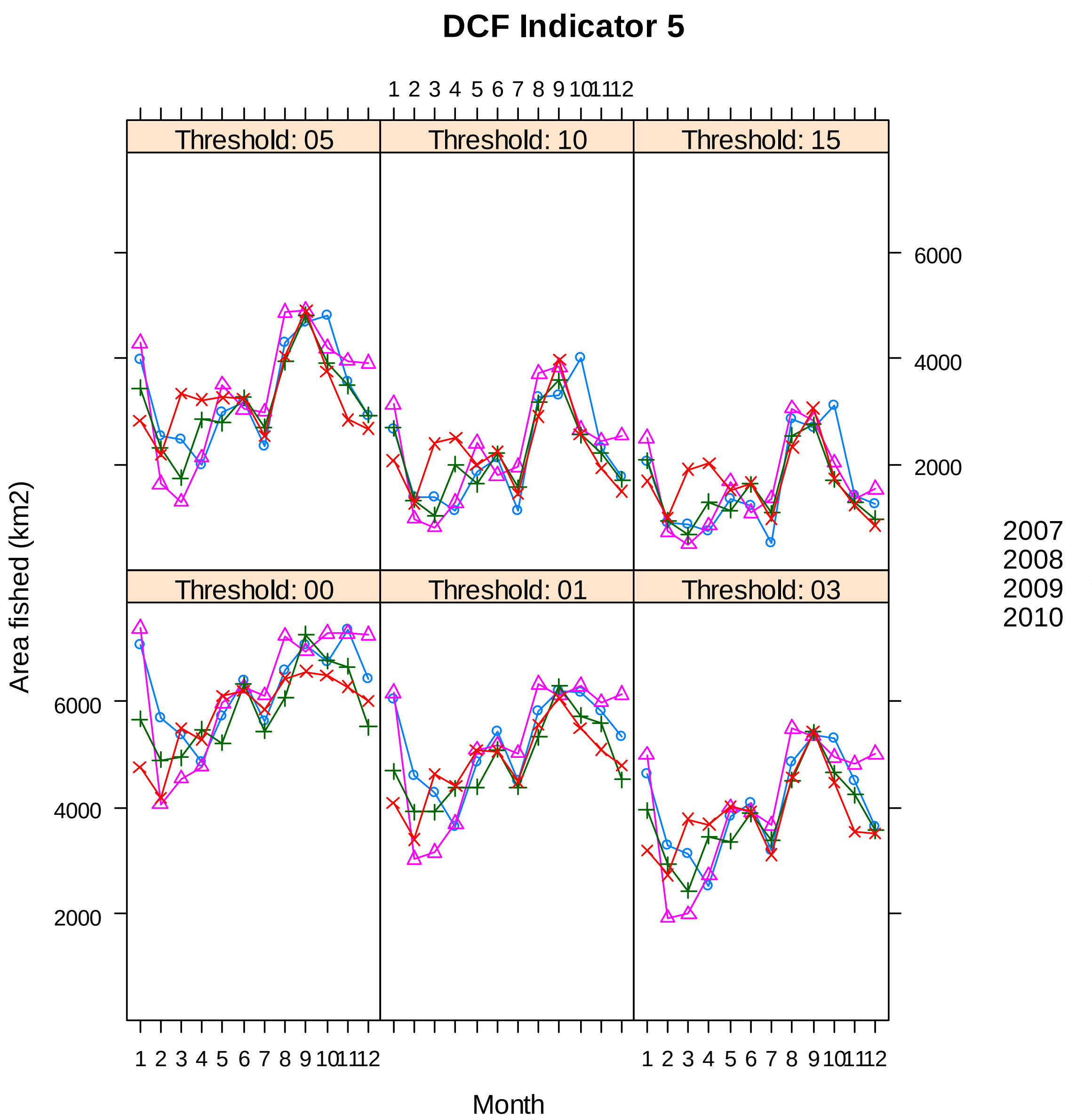



**Figure VMS-10. Spatial extent of fishing activities based on the total area of grids within which VMS record were obtained, each month. TR2 segment, Danish and Swedish data combined. Grid size 0.05 x 0.05 degree, and threshold number of records as shown on top of each plot records.**

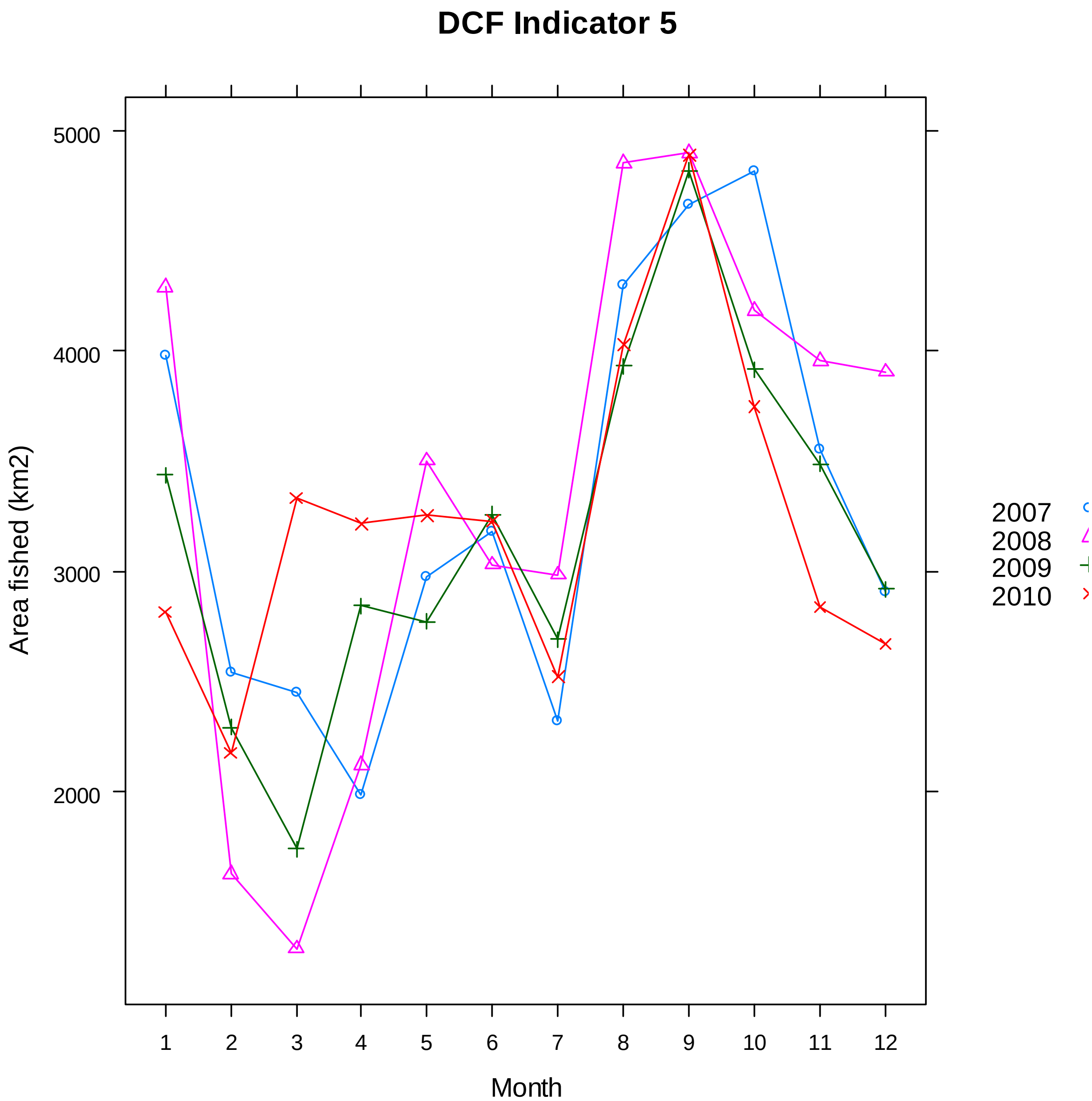



**Figure VMS-11. Spatial extent of fishing activities based on the total area of grids within which VMS record were obtained, each month. TR2 segment, Danish and Swedish data combined. Grid size 0.05 x 0.05 degree, and threshold 5 records.**

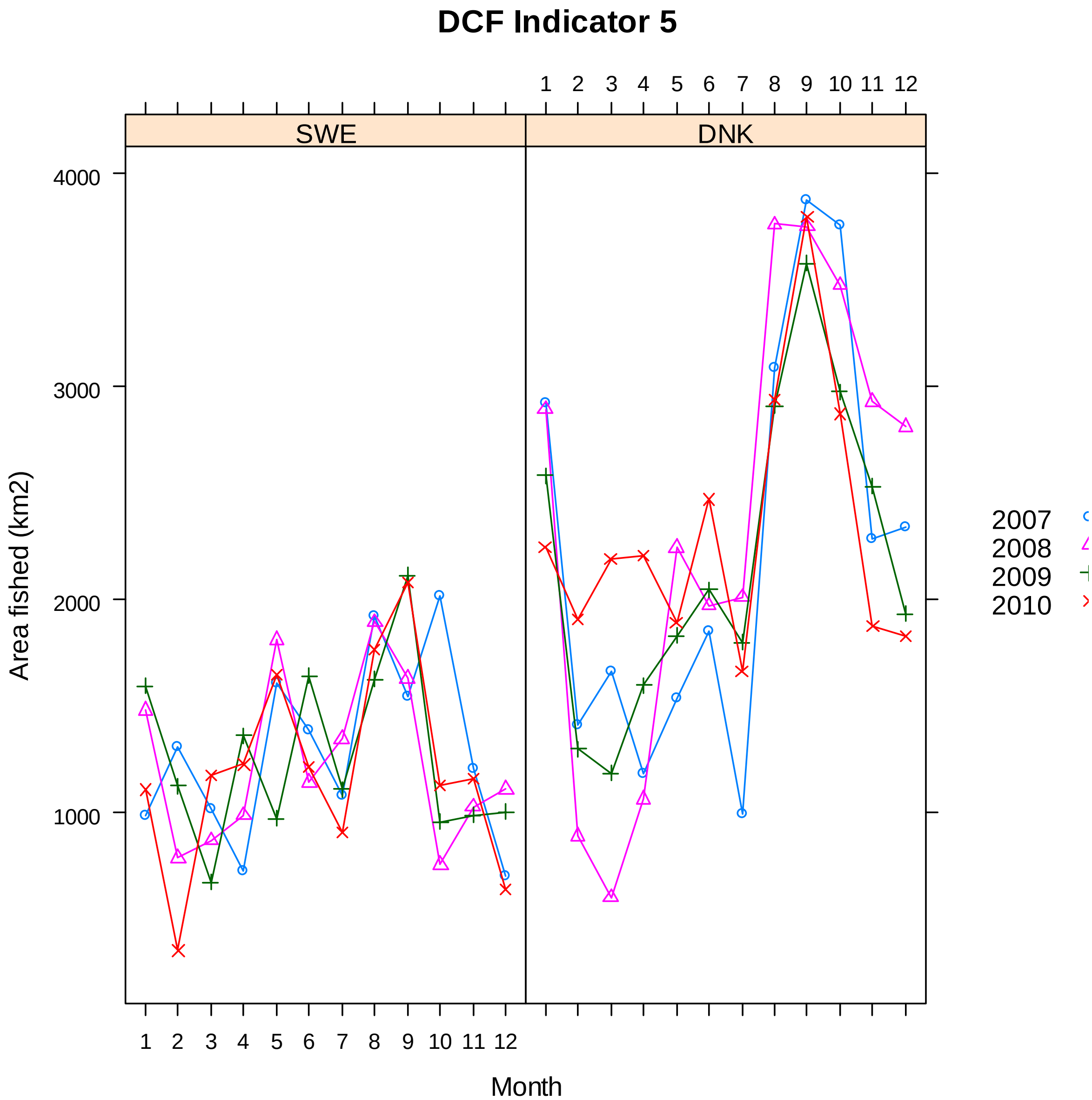



**Figure VMS-12. Spatial extent of fishing activities based on the total area of grids within which VMS record were obtained, each month. TR2 segment, Danish and Swedish separately. Grid size 0.05 x 0.05 degree, and threshold 5 records.**

## Annex 9 ANALYSIS of Irish catch data

Sarah Kraak Marine Institute Ireland

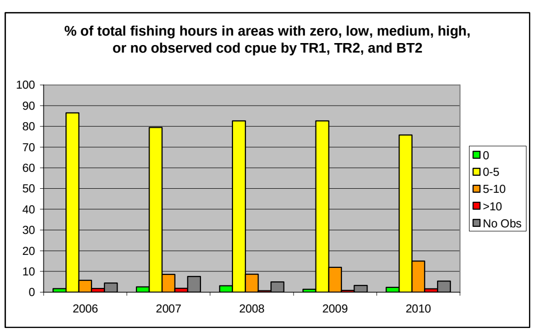
Analyses on the question "is there any evidence that effort has moved away from cod aggregations?" IRISH DATA ONLY!

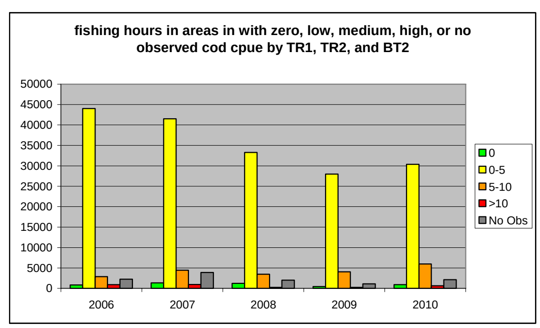
The first analysis to look at this question assumes that cod aggregations can be inferred from high cpue (lpue + dpue) from observed trips (TR1, TR2, and BT2) pooled from 1995 to present at a spatial resolution of 0.2 x 0.3 degrees (latitude x longitude). This assumes that spatial patterns are stable over the years and through the seasons. In the second analysis we release that assumption.

We prepared a VMS dataset of effort (hours fished) for 2006-2010 at the same spatial resolution. With pooled gear groups (TR1, TR2, BT2) (and using only the first three quarters because last quarter data for 2010 are not yet available) the graphs below show the amount of effort deployed in grid cells with zero, low (0-5 kg/h), medium (5-10 kg/h), or high (>10 kg/h) observer cpue levels. Analysis could be repeated by gear and/or for all 4 quarters leaving out 2010. We pooled data for VIa and VIIa; the analysis can of course be done for the separate regions. 'No Obs' refers to fishing in grid cells for which no (Irish) observer data exist.

The first graph shows the relative distribution of effort over the cells differing in cod abundance as percentage of the total effort in that year; the second graph the absolute number of hours. While in all years only a few % of effort is deployed in zero-abundance and high-abundance cells, and most of the effort is deployed in cells with low cod abundance, the data show that the effort deployed in cells with medium cod abundance steadily increased from ~5% in 2006 to ~15% in 2010. Also in absolute terms the effort deployed in these medium-abundance cells increased from 2008 onwards. This runs counter to the objective of the plan, which is cod avoidance.

NOTE: ALL FIGURES REFER TO FIRST THREE QUARTERS OF YEARS ONLY

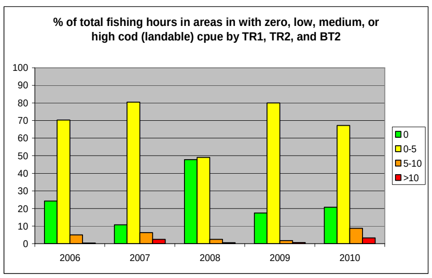


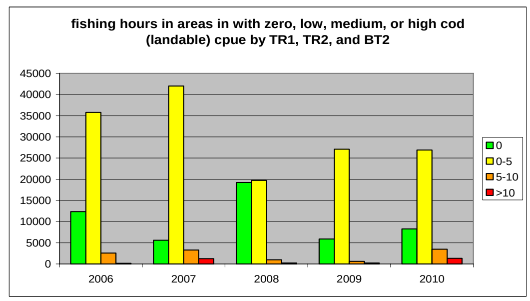



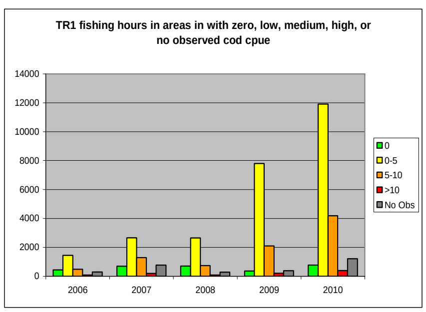

For the second analysis, releasing the assumption that spatial patterns are constant over time, we use the VMS data set combined with operational logbooks, as in Gerritsen & Lordan (2010). Hence, the catches refer to the landable cod catch (no discards). We assume that cpue (read: lpue) grid cell-week values reflect the abundance of cod in that week in that grid cell. This allows for the spatial cod patterns to change within and between years. The question becomes: is there any evidence that effort moved away from grid cells with momentary high cod abundance? In other words, is there a tendency over the years to fish relatively less in grid cell-week combinations with high cpue?

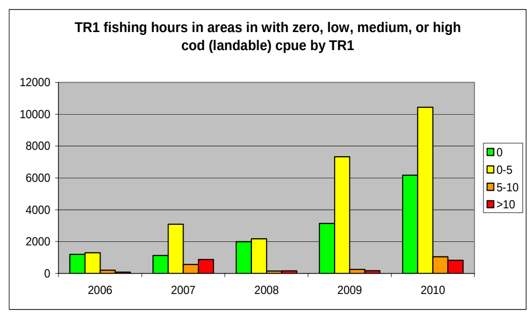
The graphs below are a little bit more difficult to interpret because the discards are not accounted for; many of the zero-cpue records must have had cod catches that were discarded. Again, and unfortunately, 2010 saw increased effort (both relative and absolute) in medium- and high-abundance cell-week combinations, which counters the objective of the plan.

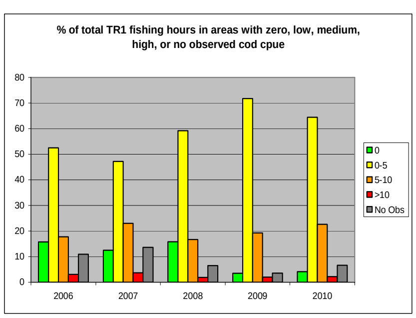
The graphs that follow are from similar analyses, but the fishing hours are treated separately for the 3 gear groups TR1, TR2, and BT2. The conclusion remains the same, namely that 2009 and 2010 did not see reduced fishing in areas with high cod abundance compared to 2008, countering the objective of the plan.

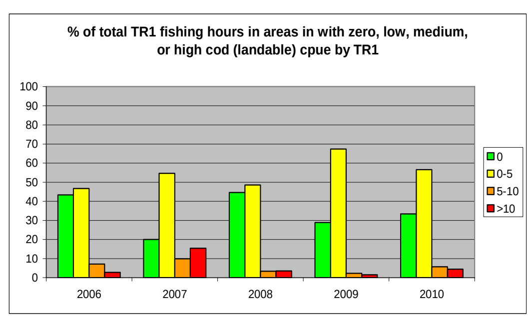


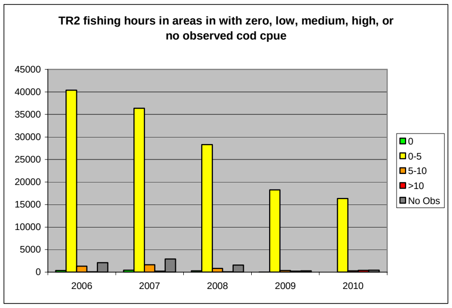




TR2 fishing hours in areas in with zero, low, medium, high, or no observed cod cpue
0
0-5
5-10
>10
No Obs
2006
2007
2008
2009
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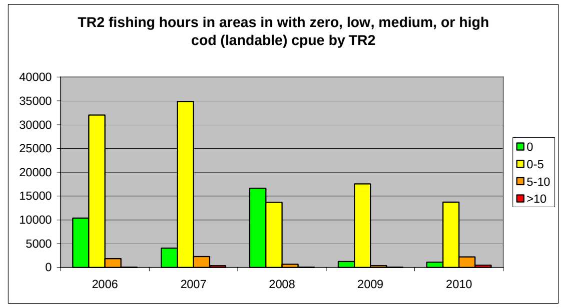
TR2 fishing hours in areas in with zero, low, medium, or high cod (landable) cpue by TR2
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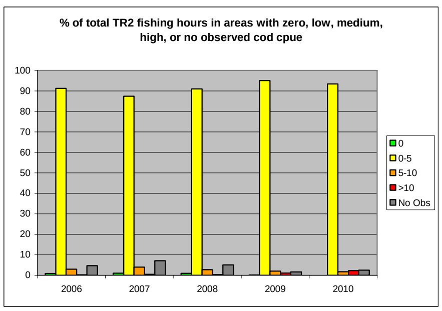
% of total TR2 fishing hours in areas with zero, low, medium, high, or no observed cod cpue
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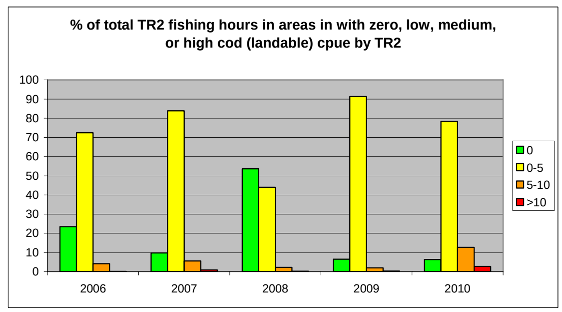
% of total TR2 fishing hours in areas in with zero, low, medium, or high cod (landable) cpue by TR2
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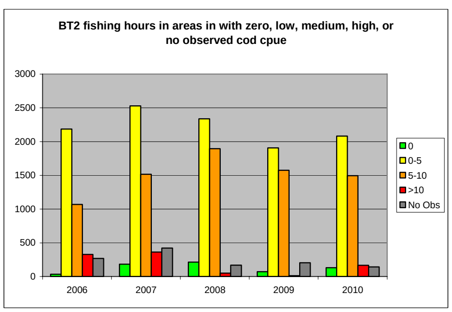
BT2 fishing hours in areas in with zero, low, medium, high, or no observed cod cpue
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0-5
5-10
>10
No Obs
2006
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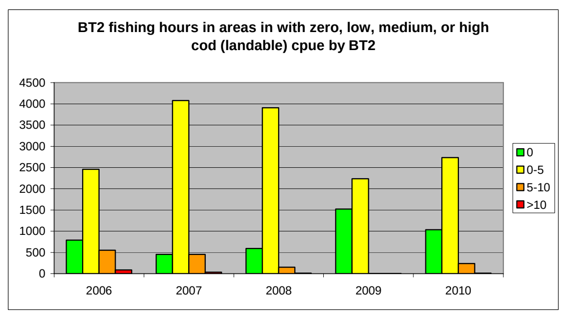
2008
2009
2010


BT2 fishing hours in areas in with zero, low, medium, or high cod (landable) cpue by BT2
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0-5
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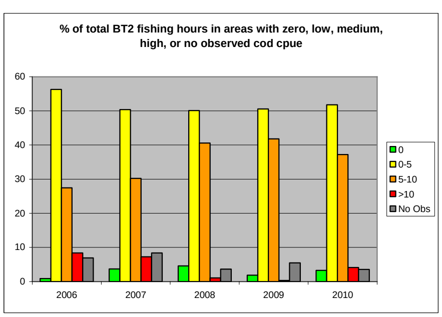
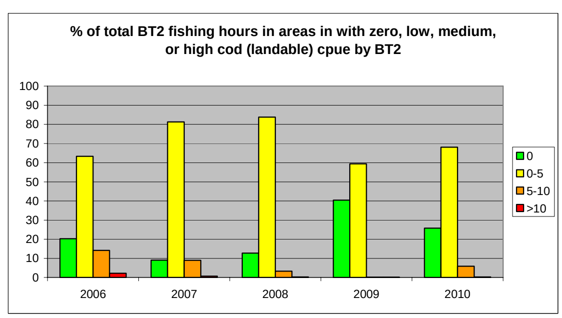

% of total BT2 fishing hours in areas with zero, low, medium, high, or no observed cod cpue
0
0-5
5-10
>10
No Obs
2006
2007
2008
2009
2010


% of total BT2 fishing hours in areas in with zero, low, medium, or high cod (landable) cpue by BT2
0
0-5
5-10
>10
2006
2007
2008
2009
2010

# Annex 10 Ecosystem changes and their potential impacts on Kattegat cod

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**Changes in the ecosystem and environment**

Integrated ecosystem assessment of Kattegat has been conducted by the Working Group of Integrated Assessment of the Baltic Sea in ICES (2010). In total, 67 variables were considered, covering hydrographic conditions, nutrients, phytoplankton, zooplankton, benthos, fish, birds and seals. The data series covered the period from 1982–2008.

The analyses used Principal Component Analyses (PCA) methods. To illustrate systematic patterns in single time-series, the "traffic-light" framework was used. An overview of the temporal changes in all time-series compiled for the Kattegat is presented in Figure 1. Variables were sorted according to their PC1 loadings of the subsequently performed PCA, generating a pattern with variables at the top that revealed an increasing trend over time (from green to red), to variables at the bottom demonstrating the opposite trend (red–green) with the highest values in the period 1982 – 1989.

Chronological clustering analyses identified an ecosystem shift in 1988 – 1989. In general, the system was more variable at the beginning of the investigated period and started to stabilize after the major shift from the mid-1990s onwards. The group of variables with increasing trends included e.g. spring and summer temperature, secchi depths, harbour seals and biomass of sole and molluscs. Decreasing values were found e.g. for salinity, nutrient conditions, primary production (across phytoplankton taxa), zooplankton taxa and fish species, such as cod and plaice. Variables with less clear trends are found at the centre of the plot, some of them demonstrating relatively high values at the be-ginning of the time-series, but also comparatively high estimates in the period from 1990 to early 2000. This includes biomass of polychaetes, crustaceans and CPUE of sprat.

Concerning cod, which is a cold-water species, the increasing temperature indicates deteriorated conditions. In addition, declining zooplankton abundances may imply lower food recourse for early life stages.

Due to increased water temperature in summer, northward migration of cod may take place. This pattern has for example been found for North Sea cod (Rindorf and Lewy 2006). The IBTS survey data from the 3rd quarter indicates that the centre of gravity of cod stock in the Kattegat during summer period has indeed shifted northwards in recent years (Annex X), which could be associated with the increasing water temperature during summer in recent period (Fig. 1). No significant change in cod distribution was detected during other periods of a year.

Potential effects of changes in zooplankton abundance on cod recruitment are addressed in the section below.

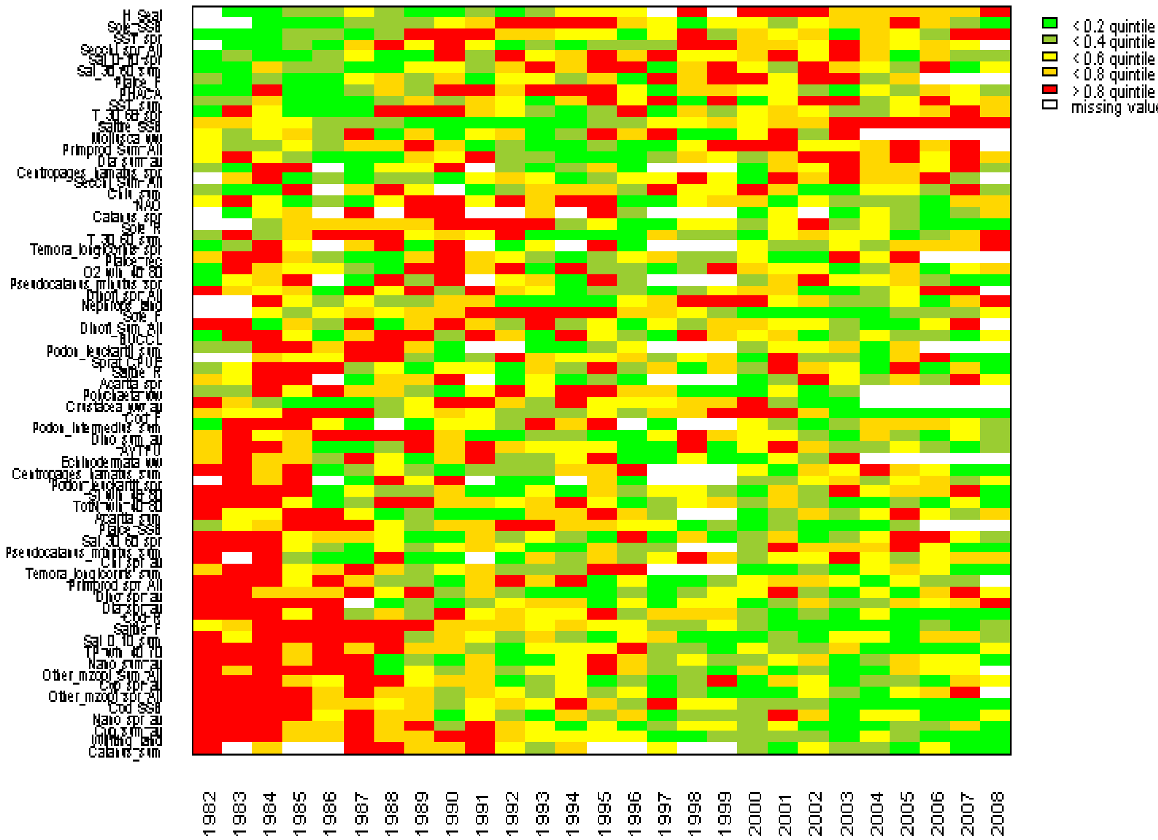


**Figure 1. Traffic-light plot of the temporal development of Kattegat time-series. Variables are transformed to quintiles, colour coded (green = low values; red = high values), and sorted in numerically descending order according to their loadings on the first principal component (ICES 2010).**

### Potential environmental/ecological effects on Kattegat cod recruitment

The recent decline in Kattegat cod stock to below ten percent of the biomass in the 1970s is considered to be generally due to high fishing pressure; significant effects of environmental variables on cod recruitment have in earlier analyses not been found (Cardinale and Svedaeng 2004). Recently, new analyses were conducted which investigated how multiple physical and biological factors could potentially influence recruitment and recovery of Kattegat cod, using generalised additive modelling and a large data set of abiotic and biotic variables (Lindegren and Eero, submitted).

These analyses identified significant effects of winter bottom (40-80 m) oxygen concentration, biomass of Centropages hamatus (annual) and Temora longicornis (spring), as well as North Sea cod recruitment, in addition to the effects of the size of the spawning stock. Forward model selection, which introduced each candidate predictor in order of significance, retained only the first two covariates, oxygen concentration and biomass of Centropages hamatus (annual), in the final model. The final model explained well the long-term dynamics and a decline of cod recruitment in the Kattegat (78.3% DEV), although some of the inter-annual variation was less well represented, especially during the last decade (Figure 2A and B). Nevertheless, observed recruitment levels are within the range of model uncertainty, i.e. within the prediction intervals. When fitted to only the first half of the time series, the model reasonably predicts the remaining part of the data, although overestimating recruitment levels in the very last two years (Figure 2B).

These analyses indicate that the present low recruitment is largely due to the historic low level of SSB in recent years. The external forcing factors, i.e. oxygen concentrations and biomass of Centropages hamatus, which have had an influence on cod recruitment over time, have generally been at an average level in recent years (Figure 3).

Potential changes in recruitment productivity were investigated using catch-per-unit of effort for 1 year-old cod as and index for recruitment. SSB was from the assessment, where the estimates for 2008-2010 were similar to the fisheries-independent biomass estimates from the joint Swedish –Danish fishermen-scientist cod survey (ICES 2011).

Recruitment produced per unit of spawner biomass does not appear to have changed in recent years, despite the very low spawning stock. This confirms that the present low level of recruitment is mainly due to low spawning stock. However, this result may be due to the effect of continued transportation of recruits from spawning aggregations in adjacent areas such as the North Sea (Cardinale and Svedaeng 2004), which might bias the estimates of recruitment productivity of the Kattegat population.

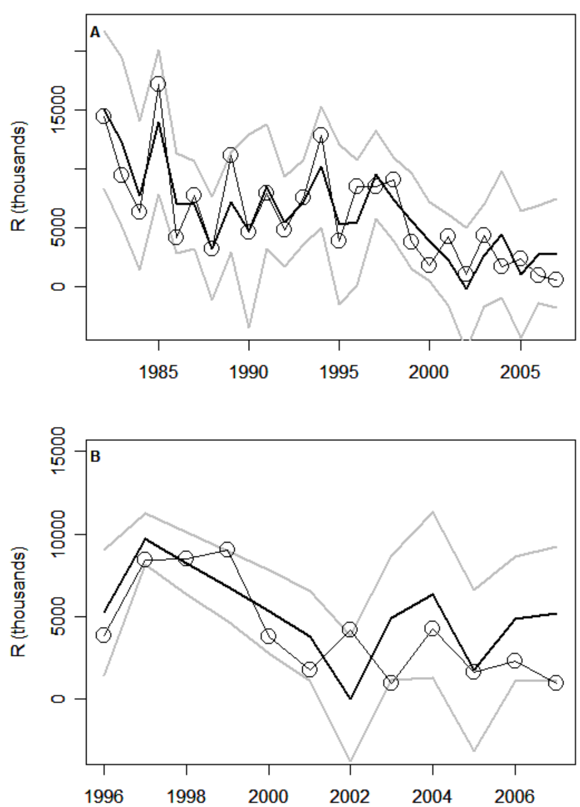


**Figure 2 (A) Observed (white) and simulated cod recruitment (black) based on the final GAM. (B) Predictions for 1996-2008 based on model fitting on a data set from 1982-1995 only. Upper and lower 95% prediction intervals are shown in grey (Lindegren and Eero, submitted).**

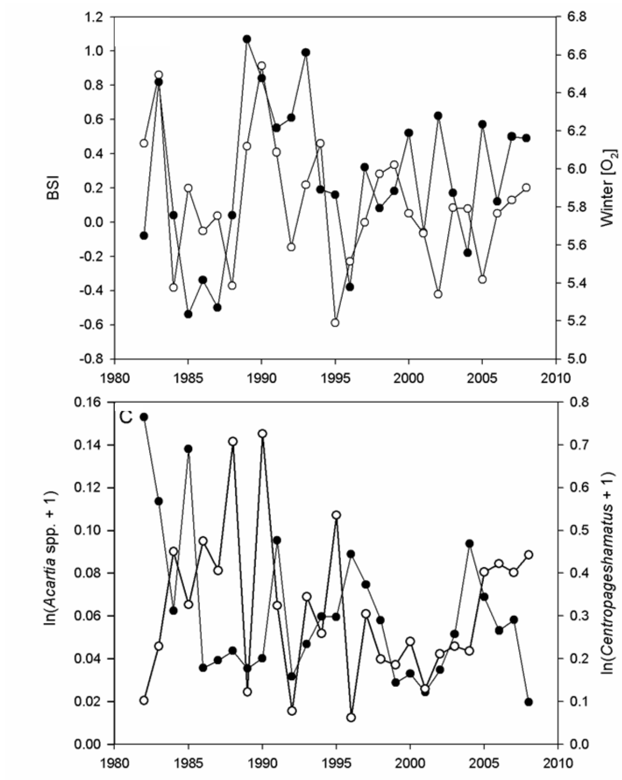


**Figure 3. Atmospheric- and hydrographic conditions illustrated by the Baltic Sea Index (BSI, black) and winter bottom oxygen conditions (white), respectively (upper panel). Potential prey availability for cod larvae, *Centropages hamatus* (black) and *Temora longicornis* (white), representing annual and spring averages, respectively (lower panel) (Lindegren and Eero, submitted).**

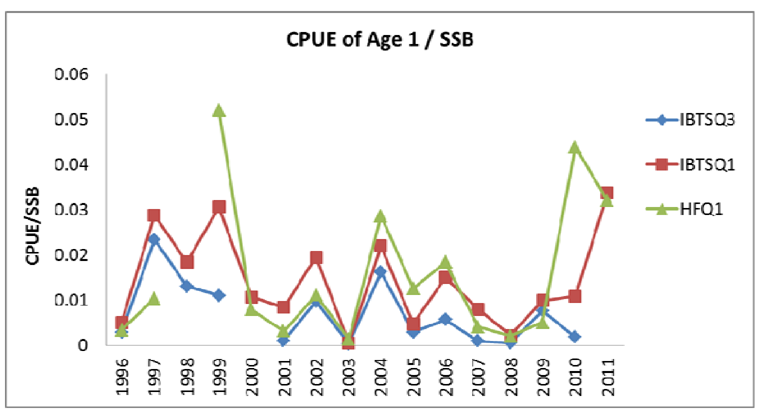


**Figure 4. Relative recruitment production, shown as CPUE of cod at age 1 from surveys relative to SSB from the assessment.**

## References


Cardinale, M., Svedaeng, H. 2004. Modelling recruitment and abundance of Atlantic cod, Gadus morhua, in the eastern Skagerrak–Kattegat (North Sea):evidence of severe depletion due to a prolonged period of high fishing pressure. Fisheries Research 69 (2004) 263–282

ICES 2010. Report of the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB) ICES CM 2010/SSGRSP:02

ICES 2011. Report of the Baltic Fisheries Assessment Working Group, 12–19 April, ICES Headquarters, Copenhagen. 2011 ICES CM 2011/ACOM10.

Lindegren, M., Eero, M. Multiple abiotic and biotic factors limit recruitment and recovery of Kattegat cod (Submitted).

Rindorf, A., Lewy, P. (2006). Warm, windy winters drive cod north and homing of spawners keeps them there. Journal of Applied Ecology, 43: 445-453.

# Annex 11 Recent changes in fisheries regulations and fisheries for cod in the Kattegat

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## 1. Fisheries regulations

### TAC

TAC for cod in the Kattegat has continuously been reduced since 2004 (Table 1). The agreed cod TACs have been in accordance with Article 9 of the management plan since the implementation of the plan in 2009. In the absence of reliable forecasts the TAC was reduced by 25% in 2009 and 2010. In 2011 the TAC was reduced even more (-50%).

**Table 1. TAC of cod in the Kattegat**

| Year | TAC ( '000 t) |
|---|---|
| 2004 | 1.363 |
| 2005 | 1 |
| 2006 | 0.85 |
| 2007 | 0.731 |
| 2008 | 0.673 |
| 2009 | 0.505 |
| 2010 | 0.379 |
| 2011 | 0.19 |

### 1.1 Effort and gear regulations

Besides TAC regulation, fishing in Kattegat is restricted by effort limitations. The system was first introduced in the first cod recovery plan (EC No. 423/2004). Effort was limited by allowed number of fishing days for individual fishing vessels. The system was quite complicated since different types of fishing gear, mesh-size ranges and types of selection devices gave different number of allowed fishing days. The sorting grid used in Swedish *Nephrops* fisheries was given unlimited days since it was shown that by-catches of cod were very small. In 2007 fishermen were allocated additional fishing days when using trawls with an exit-window with square-meshes at a minimum 120 mm. Since 1st February 2008, the usage of the exit-window in trawls has been made mandatory in Denmark. In 2008, in order to restrict the targeted Kattegat cod fisheries, each fishing day during the period between 1 February and 30 April was further counted as 2.5 days. In 2009, following the introduction of the new management plan (EC No. 1342/2008) for North Sea (incl. Kattegat) cod a new effort system was introduced. In this system each Member State is given amounts of kWdays for different gear groups. It is then the MS responsibility to distribute the kWdays among the fishing vessels. The amount of kWdays for gear groups catching cod will be subject to yearly cuts as long as the cod stock is below reference points in the management plan. The cod recovery plan does include two main exceptions to the overall regime. Firstly, according to Article 11, paragraph 2, the Council may decide to exclude certain groups of vessels from the effort regime provided that the percentage of cod catches as assessed by STECF does not exceed 1.5 % of the total catches for the group concerned. This may arise from either the use of a highly selective gear, such as the Swedish sorting grid used in the fishery for Norway lobster, or from fisheries in restricted geographical areas.

Secondly, Article 13 opens the possibility of increasing the maximum allowable fishing effort for certain effort groups, if certain other measures are taken that reduces fishing mortality for cod. This increase in effort shall be no more than the amount needed to compensate the effort adjustments made annually. Denmark introduced a cod avoidance plan in 2010 which includes initiatives in relation to article 13 (effort) of the long-term plan for cod. These include, amongst other, introduction of a new selective trawl SELTRA 180.

### 1.1.1 Protected areas

In 2009, as a part of the attempts to rebuild the cod stock in the Kattegat, Denmark and Sweden introduced protected areas on historically important spawning grounds. The protected zone consists of four different areas in which the fisheries are either completely forbidden or limited to certain selective gears (Swedish grid and Danish SELTRA 360 trawl) during all or different periods of a year (Fig. 1).

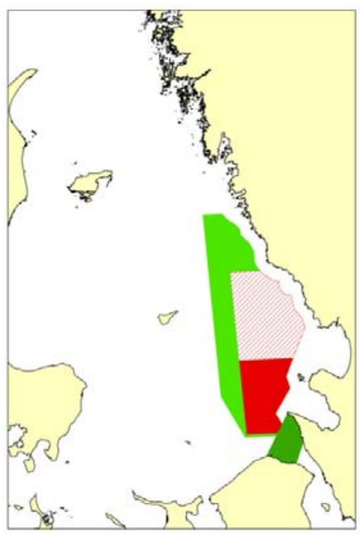

Figure 1. Protection zones for Cod in the Kattegat. The red zone is closed for all fisheries the whole year. In the red striped area, all fisheries are forbidden between the 1st of January to the 31st of March; from the 1st of April to the 31st of December only selective gears are allowed. In the light green area, only selective gears are allowed from the 1st of January to the 31st of March; during the rest of the year the area is open for all gears. In the dark green area, only selective gears are allowed from the 1st of February to the 31st of March; during the rest of the year the area is open for all gears.

### 1.1.2 ITQ– FKA

Before 2007, the quotas in Denmark were split into 14-days rations which were continuously adjusted to the amount of quota left. As a result of a new national regulation of Danish fisheries, from 2007 Danish fishermen have been allocated vessel quota shares (ITQ/FKA) and corresponding yearly quotas. An opportunity to fish vessel quota shares in pools with other vessels was also introduced. This system is a type a co-management of the quotas whereby fishermen through a transparent market have better opportunities to plan their fishing activity and to ensure that the vessels' quotas match the catches. The system is supervised and controlled by the Danish Directorate of Fisheries.

**Minimum landing size**

The Danish minimum landing size was set down to 30 cm in 2008, in order to match the international minimum landing size and potentially reduce cod discards. However, this reduction in minimum landing size does not seem to reduce the discards as the cod at this length is apparently not considered marketable, resulting in about 20% of Danish cod discards in 2010 being above the minimum landing size (Fig. 2).

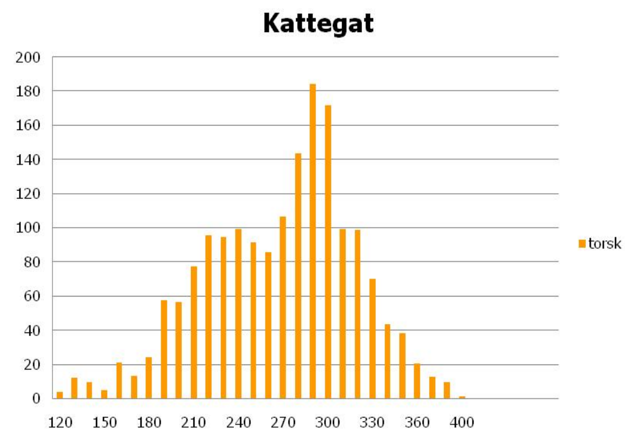


**Figure 2. Length distribution of cod in the Danish discards in the Kattegat in 2010.**

## 2. Developments in fishing effort

Total effort (kw-days) of TR2 segment (79-99mm mesh size), which is the main segment catching cod in the Kattegat, has been reduced by ca 25 % compared to the level in 2004 (STECF 2011). However, the total effort in 2009-2010 has been stable. Swedish effort has continued to decline in the period 2008-2010, wheras Danish effort is showing an increase (Fig. 3). The proportion of effort by vessels using selective gears has been increasing in recent years. Around 60% of Swedish effort in segment TR2 in 2010 was by gears with sorting grid (CPART11), with is about 15 % of the total effort of this segment in the Kattegat (Fig. 4). Most of the total effort of TR2 segment in 2010 belonged under the category CPART13 (Article 13, which opens the possibility of increasing the maximum allowable fishing effort, if certain other measures are taken that reduces fishing mortality for cod).

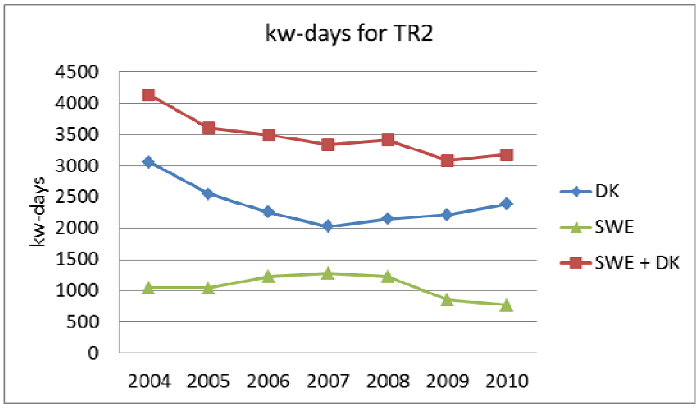


**Figure 3. Effort (kw-days) of TR2 segment (70-99 mm mesh size) by Sweden and Denmark and for the two countries combined (data from STECF 2011).**

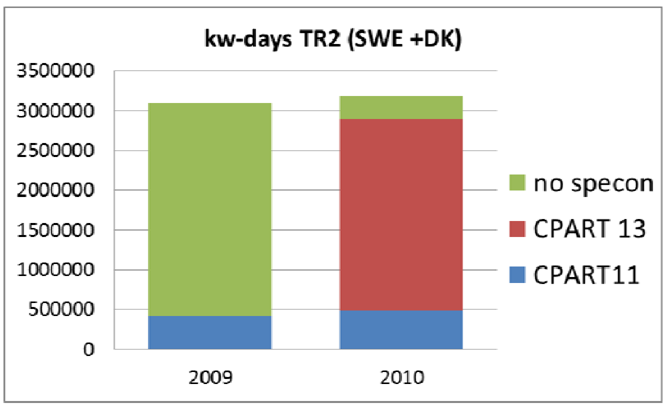


**Figure. 4. Proportion of total effort (kw-days) in TR2 segment where no special conditions apply and the proportion of effort under special conditions according to the Article 11 (CPART11) and Article 13 (CPART13) in 2009 and 2010 (data from STECF 2011).**

## 3. Cod landings

### Commercial landings

Agreed TACs and reported landings have been significantly reduced since 2000 to the present historical low level. Before 2007, TAC regulation was implemented through a ration-period system, both in Sweden and Denmark, and the rations in the Kattegat were lower than those in adjacent areas. This could have given incentives for misreporting of catches by area (Hovgård, 2006), that could potentially have biased landings statistics for some years. In recent years, reported cod landings in the Kattegat have been below TAC (Fig. 5). The reported landings in 2010 were 155 tons, while the TAC was 379 tons. Along with declining catches, the importance of cod for the fisheries in the Kattegat has become negligible. In 2010, the value of Danish total catch amounted to 160 mill Dkr. were 62% came from the *Nephrops* landings, 14% from the Sole landings and only 1% from the cod landings (Fig. 6). This is a clear reduction from 2002 when cod contributed 13% to the total catch value in the Kattegat.

The proportion of fishing trips in the Kattegat where cod is landed has substantially decreased in recent years. In early 2000s, some cod was still landed in majority of fishing trips by the Danish Nephrops fleet. In 2009-2010, during most of the trips no cod was landed or the amounts were below 10 kg per trip (Fig. 7).

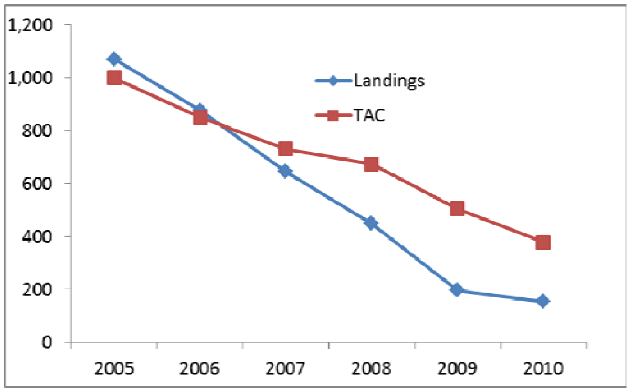


**Figure 5. Total reported landings of cod in the Kattegat compared to TAC.**

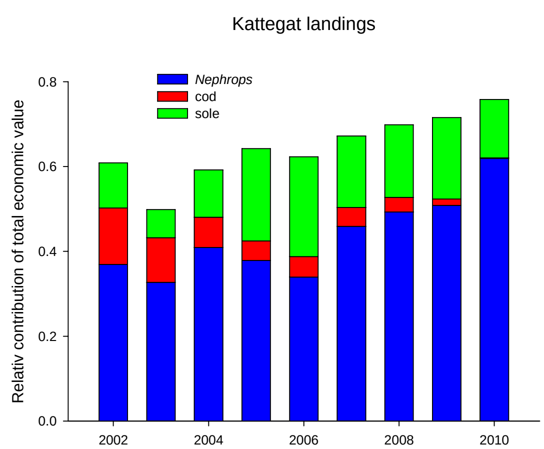


**Figure 6. The relative contributions of Nephrops, sole and cod to the Danish catch value in the Kattegat.**

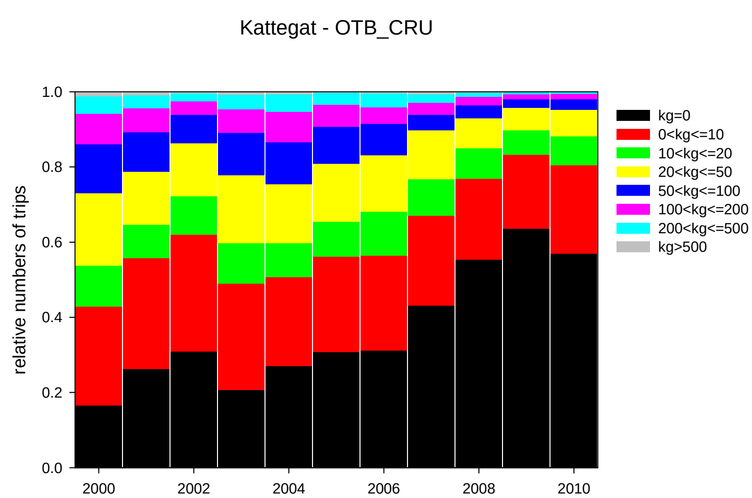


**Figure 7. The relative numbers of trips by the Danish Nephrops fleet with different amount of cod landings. 0 kg cod, 0-10 kg, 10-20 kg, 20-50 kg, 50-100 kg, 100-200 kg, 200-500 kg, >500 kg.**

**Recreational catches**

In order to estimate cod catches by recreational fishery in Denmark in 2009 and 2010, recall surveys were conducted. Recall survey is a type of off-site survey which relies on collecting information through mail, telephone or internet interviews where respondents are asked to recall e.g. their catches, fishing pattern or number of days fished, within a specific timeframe. The result showed that a total of 1630 t cod were caught in the Danish recreational fishery in 2010, 4% of which (i.e. around 65 t) were taken in Kattegat. Cod landings in the Kattegat by Danish recreational fishery in 2009 have been estimated at 35 t (Sparrevohn & Storr-Paulsen 2010). Thus, the Danish recreational cod landings in the Kattegat in 2010 were higher than Swedish commercial cod landings in the area (Fig. 8).

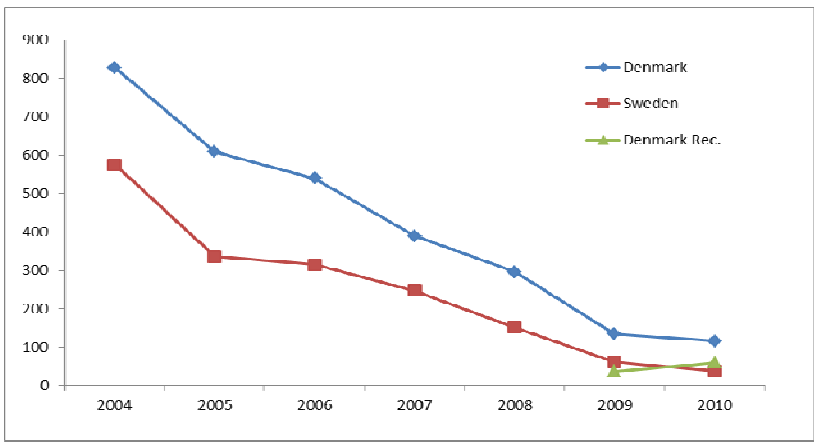


**Figure 8. Danish recreational cod landings in the Kattegat in 2009-2010 compared to commercial landings by Sweden and Denmark.**

## 4. Cod discards

Estimates of discards are available from Swedish and Danish onboard sampling programs. The Swedish discard data indicate that although the cod landings have substantially declined since the 1990s, the amount of discards has until recently been stable (Fig. 9). Since about 2007, Swedish cod discards have substantially declined, which is likely due to introduction of selective gears (sorting grid) and probably also due to reduced stock size. During the years 2004-2007, Sweden had serious problems with discards of marketable cod due to quota restrictions/exhaustions. In these years the proportion of discards in catch is estimated to have been the highest and coincides with the years of largest discrepancy between landings and estimated removals (Fig. 14b). The level of discards in the Danish fisheries in 2008-2010 is indicated to be somewhat higher compared to the Swedish (Fig. 10). In total, about a half of the amount of cod caught in the Kattegat (in tonnes) is currently discarded (Fig. 11).

Even though the quota has not been utilized since 2007, there is some indication of high-grading in Kattegat and that high-grading has been an increasing problem since 2007 when the new Danish regulation system was initiated with Vessels quota shares. Comparison of the relative distribution of the different size categories over time shows a large decrease in the smallest size group of cod (size group 5) in landings in 2007-2008, however in 2010 the proportion of sorting group 5 has been increasing (Fig. 12).

In the Danish observer tours in the Kattegat where cod has been caught (6 trips), 23% of the discarded cod were above the minimum landing size in 2010 (Fig. 2). Data from these trips also indicate that the proportion of cod at the smallest sorting category (5) has been about 50% higher when the observers have been onboard, compared to the trips without an observer (Fig. 13). This could indicate that the discards of cod in the Kattegat are higher than estimated from the data collected in observer trips.

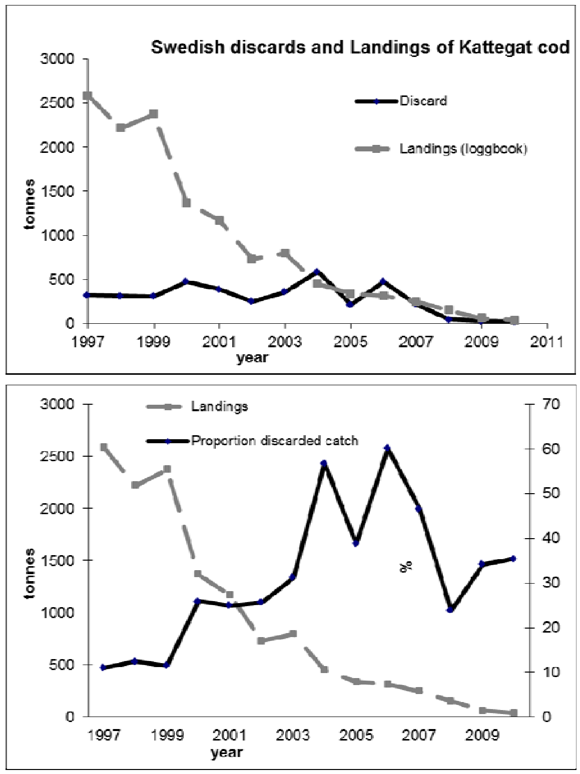


**Figure 9. Landings and discards of cod in the Swedish fisheries in the Kattegat and the proportion of discards in total catch.**

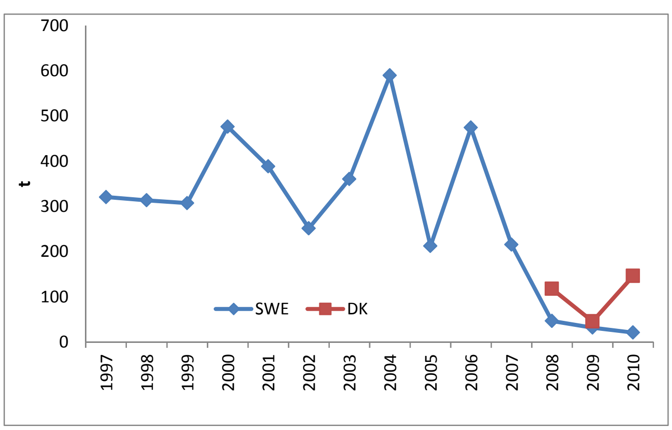


**Figure 10. Total cod discards (tonnes) in Swedish and Danish fisheries in the Kattegat.**

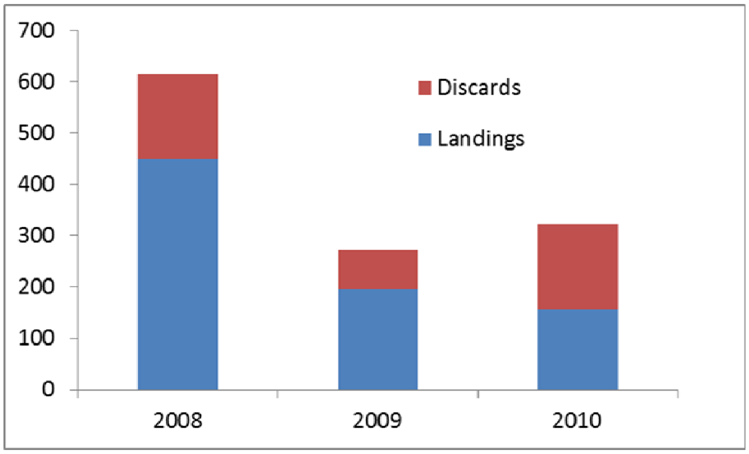


**Figure 11. Relative proportions of discards and landings in total cod catches (Sweden + Denmark) in the Kattegat.**

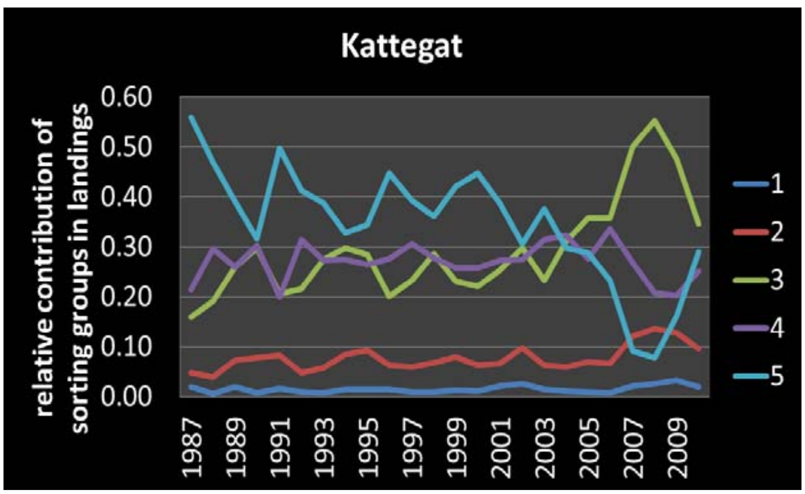


**Figure 12. Relative (in percentage) Danish cod landings in the Kattegat by sorting categories (sort 1: >7 kg, sort 2: 4-7 kg, sort 3: 2-4 kg, sort 4: 1-2 kg, sort 5: 0.3-1 kg).**

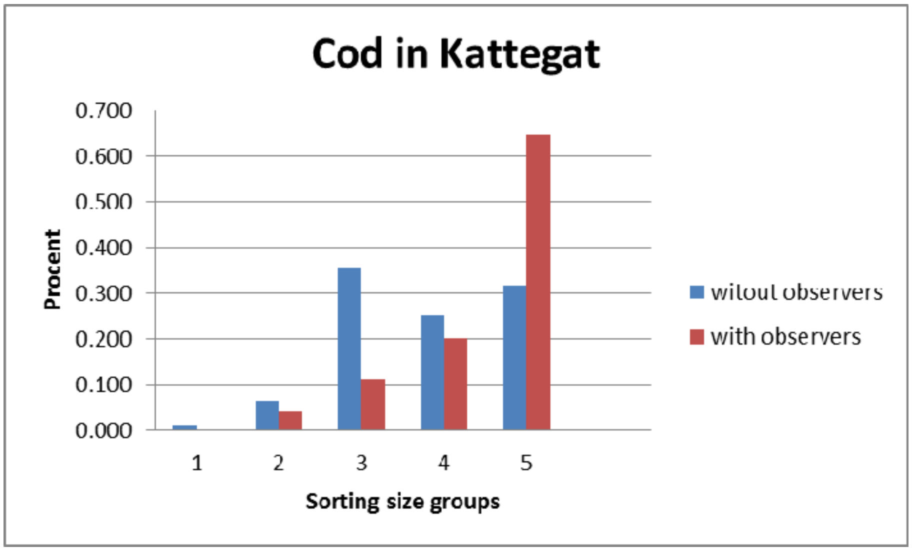


**Figure. 13. Proportion of cod at different sorting categories (5 refers to the smallest and 1 to the largest cod) in landings when observers have been onboard (based on 6 trips) compared to the non-observed tours. Based on Danish data for 2010.**

## 5. Fisheries removals compared to the estimated total removals from the stock

The Kattegat cod stock assessment (ICES 2011) using SAM model provides two very different results concerning recent developments in fishing mortality (F), depending on whether landings are assumed to represent fisheries removals, or whether the recent developments in F are estimated mostly from survey data (Fig. 14a). Low landings in recent years indicate a drastic decline in F and current F at a very low level (0.1), whereas the survey data indicates the current F to be at a much higher level (around 1.0), without showing any major change in recent years. Accordingly, the survey data indicates that total removals from the stock in 2003-2010 were significantly higher than represented by landings (Fig. 14b). There could be several reasons for this discrepancy, e.g. discards, migration, or higher natural mortality than assumed. The assessment is at present run without the discards. To obtain an estimate of total fisheries removals, the available information on the amount of discards and also landings from recreational fishery were added to the reported commercial landings. This resulted in total catch about 3 times higher than reported landings in 2010 (Fig. 15). Nevertheless, this estimate of total fisheries catch is still about 50% lower than the estimates total removals (Fig. 15). Thus, given the available information on landings and discards, the fisheries related- removals can unlikely explain the magnitude of estimated total removals from the stock.

Estimates of high fishing mortality from the survey data are due to low and continuously declining numbers of especially older cod caught in surveys (Fig. 16). The recent data indicates that the CPUE of younger age-classes is increasing in latest years, probably due to somewhat stronger incoming year-classes; whereas the CPUE of older cod continuous to decline, resulting in high mortality estimates.

One possible explanation to this could be migration of cod out of the area. This could possibly be related to mixing of stocks. There are indications of a significant transportation of cod larvae from the North Sea stocks into the Kattegat. Immature cod in the

Kattegat are an assortment of North Sea and Kattegat stock components. The principal age when most return migration from the Kattegat towards the North Sea seems to take place is observed to be at age 2 to 3 (Svedäng et al. 2007). An increasing proportion of fish originating from other stocks due to the decline of the Kattegat cod could thus seriously affect estimations of population parameters and bias the fishing mortality estimates.

Further, relatively higher summer water temperature may cause northward migration of cod in the Kattegat (see also Annexes X and Y) as has been observed in other areas (Rindorf and Lewy 2006). This could potentially contribute to the high mortality estimates if the cod are moving out of the Kattegat.

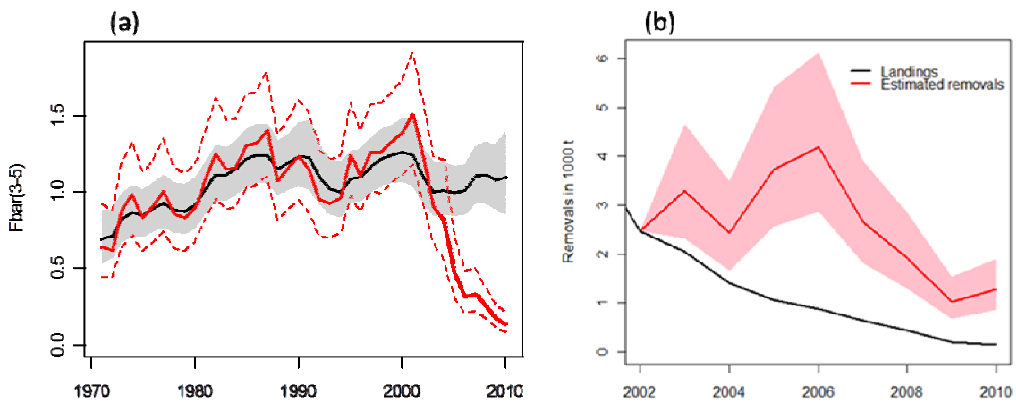


**Figure 14. (a) Mortality in excess to assumed natural mortality, estimated from SAM model, from the runs with (black line) and without (red line) estimating unallocated removals. Shaded area and broken lines represent 95% confidence intervals for the runs with and without estimating unallocated removals, respectively. (b) Total removals from the stock in excess to assumed natural mortality, estimated by SAM model, compared to reported landings (ICES 2011).**

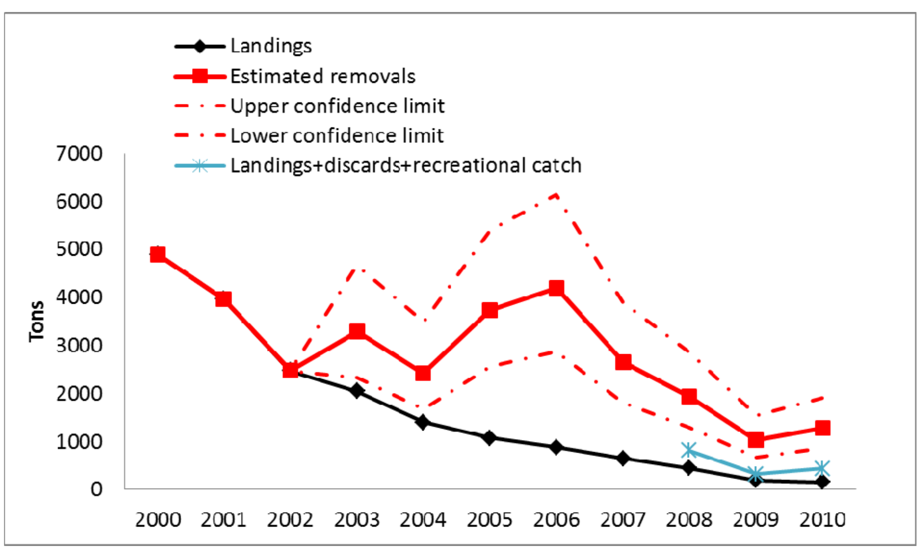


**Figure 15. Estimated total removals from the stock (in excess to the assumed natural mortality) from SAM model (solid red line) compared to available information on fisheries removals (solid blue line), which is the sum of reported landings (black line), estimated discards and recreational catch.**

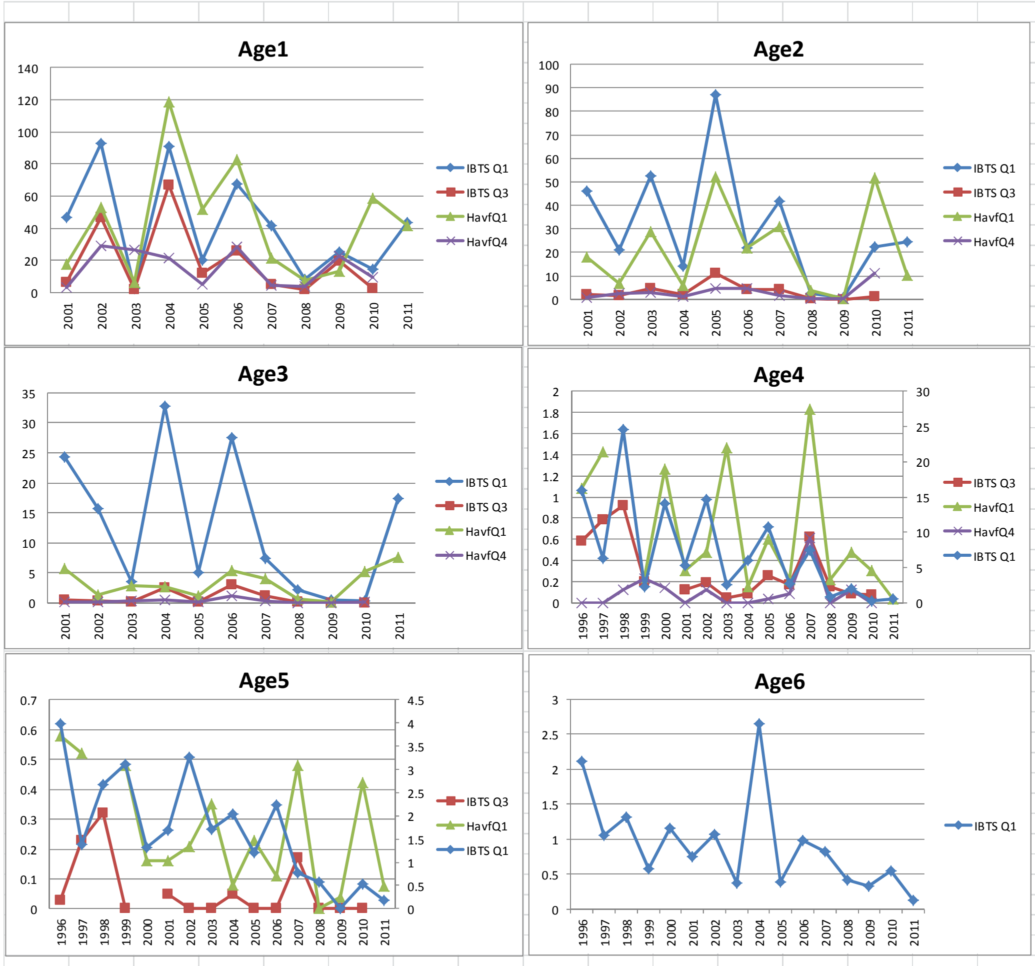


**Figure 16. CPUE of cod in the Kattegat from different surveys, by age.**

## References

Hovgård, H. 2006. A compilation of information relevant for evaluating misreporting of cod in Kattegat. ICES CM 2006/ACFM:24, Working Document 6

ICES 2011. Report of the Baltic Fisheries Assessment Working Group, 12–19 April, ICES Headquarters, Copenhagen. 2011 ICES CM 2011/ACOM10.

Rindorf, A., Lewy, P. (2006). Warm, windy winters drive cod north and homing of spawners keeps them there. Journal of Applied Ecology, 43: 445-453.

Sparrevohn, C. R.; M. Storr-Paulsen 2010. Eel and cod catches in Danish recreational fishing : Survey design and 2009 catches in series: DTU Aqua-report (ISSN: 1395-8216) (ISBN: 978-87-7481-110-7) , pages: 23, 2010, DTU Aqua, Charlottenlund

Svedäng, H., Righton, D. and Jonsson, P. 2007. Migratory behaviour of Atlantic cod Gadus morhua: natal homing is the prime stock-separating mechanism. Marine Ecology Progress Series 345:1-12.

# Annex 12 Evaluation of the effects of the multi-annual plan on the stock

*WD to WKROUNDMP 2011*

Rob Scott, Alexander Kempf, Clara Ulrich, Steven Holmes, Margit Eero, Jan Peter Schon

The plans objectives are defined in terms of fishing mortality reductions. In the case that there is an accepted assessment (North Sea cod), it is evaluated if the fishing mortality has reduced as intended since the implementation of the plan. Exploitation rates were inspected using the latest assessment, and compared to the fishing mortality in 2004 (2005 start of the implementation of the old cod recovery plan; EU 2004)) and 2008 (2009 start of the implementation of the new cod management plan; EU 2008)) respectively. In cases where no reliable fishing mortality estimate is available from analytical assessments (Kattegat Cod, Cod West of Scotland, Irish Sea cod), only proxies such as biomass trends were used to judge whether biomass is above biomass trigger levels as specified in the regulation. In addition to the biomass proxies, changes in the productivity and recruitment success were evaluated for all four stocks.

In a second step, the focus was on the implementation details causing the deviations from the plan. In order to elucidate the source of the deviations from the plan, several analyses were carried out for the four stocks:

Estimation of the difference between the TAC advice according to the plan based on the historic assessments and forecasts and the actual TAC decided by the council. It was elucidated what the TAC decided by the council implies in terms of predicted F and SSB developments according to the short term forecasts used as basis for advice and final decisions. For this purpose we analysed ICES advice option tables. If the TAC was in between two options presented, a linear interpolation was used.

Analysis on whether the catches were limited by the TAC (which in effect only limits landings) as expected. To this end it was analysed how the proportionality between the different sources in the catch (discards, landings, unaccounted removals) changed over time.

Analysis on whether assumptions and results from the short term forecast on which the advice was based were consistent in retrospect or whether they have contributed to the deviations from the planned exploitation.

## 1. Introduction

### Brief History of Cod Management Measures

Prior to 2004 emergency recovery measures had been implemented on an individual basis.

Recovery plans for cod were first implemented in the Irish Sea in 2000. Two emergency closed areas were established (EC.304/2000) in which fishing for cod was prohibited between 14th February and 30th April. Subsequent regulations (EC.2549/2000 and EC.1456/2000) established additional technical measures for the protection of juveniles. The closed area in the western Irish Sea was continued in subsequent years.

A derogation to fish inside this closed area has applied in all years for vessels fishing for *Nephrops*.

Emergency measures were enacted in 2001 for the West of Scotland consisting of area closures in the Clyde from 6th March to 30th April. An additional closed area, known as the windsock (EC.2287/2003) was implemented in 2004 and has remained in force since. In addition there have been unilateral closures, by Ireland, of a traditional fishery for juvenile cod off Greencastle. This voluntary closure was in force for variable periods of time between 2003 and 2006

In the North Sea in 2001, a cod closure area was introduced as part of the stock recovery programme (EC.259/2001). The area was closed to any fishing activity during this period, with the

exception of purse seining and trawling for sandeels and pelagics. This temporary closed area was designed to cover the main spawning period of cod in the North Sea, and was in force throughout the period 14 February to 30 April 2001. In addition, TAC reductions in 2001 and 2002 were aimed at reducing fishing mortality by more than 50 per cent. Fishing effort restrictions were also implemented from 1 February 2003 for vessels of overall length greater than or equal to 10m. This restricted the number of days per month different types of vessels (i.e., using different gear types) could employ in different parts of ICES areas IV and IIIa (EC.671/2003, amending EC.2341/2002).

Council regulation EC.423/2004 established a raft of measures for the recovery of cod stocks. These included mulit-annual process for the selection of TACs, restriction of fishing effort, technical measures, control and enforcement and accompanying structural and market measures.

### Available Data and Methods

Data have been obtained from a number of different sources. The agreed TACs in each year have been taken from the council regulation on fishing opportunities for that year. The officially reported landings and ICES advice has been sourced from the annual ICES advice summary sheets, and STECF advice has been obtained from the appropriate sections of the Consolidated Reviews of Scientific Advice for Fish Stocks of Interest to the European Community. Where necessary, reference has been made to the ICES reports of the stock assessment working group for a given stock.

All analyses were conducted using R and FLR with the following package versions.

R version 2.11-1

FLCore version 2.3-800

FLAssess version 2.0-1

Flash version 0.7-1

## 2. Kattegat cod

### Achievement of objectives

In the Kattegat, the assessment used for advice in ICES suffers from uncertainty in the fishing mortality. This uncertainty is caused by uncertain estimates of unallocated removals (UR). The benchmark assessment workgroup in 2009 (WKROUND 2009) concluded that the results from runs with and without estimating unallocated removals should both be considered as final assessments (ICES WGBFAS 2011). This is because the proportion of the fisheries and biology driven factors (migration patterns) in estimated unallocated removals can at present not be specified. In the absence of additional information, the evaluation on the impact of the management plan on the stock has been done using assessment results from runs with and without estimating unallocated removals.

The SSB of cod in the Kattegat steadily declined from around 35 000 tons in the late 1970s to 5000 tons in the end of the 1990s (Figure 1). Since 2000, the SSB is estimated in both assessments to be below $B_{lim}$ (6000 tons). The SSB in the beginning of 2011 (2045 t with UR; 1815 t without UR) is estimated to be above the SSB in the beginning of 2010 (1299 tons with UR; 915 tons without UR). However, estimates for the final year are always most uncertain and this has to be confirmed by future assessments. In the assessment without estimation of UR, SSB decreased by 34% between 2004 and the beginning of 2011, but increased by 8% since 2008. Taking unallocated removals into account leads to an estimated SSB reduction of 51% between 2004 and the beginning of 2011 and to a decrease by 21% since 2008. Recruitment in recent years has been among the lowest in the time series without any sign of improvement since 2000. Current level of fishing mortality is likely in between the two very different estimates from the two runs. Under the assumption of no unallocated removals F in 2010 (0.1) is estimated to be well below the target of the plan (0.4) and F decreased by 50% since 2008 and by 84% since 2004. Officially reported landings decreased substantially (Figure 1) and the reported landings of cod in the Kattegat in 2010 were 155 tons, while the TAC was 379 tons. Taking unallocated removals into account leads to an estimated F2010 of 1.1 with only a marginal decrease in F since 2008 (2%) and an increase since 2004 (8%). The scaling factor for the estimation of unallocated removals increased from 1.61 in 2003 to 8.28 in 2010 (ICES WGBFAS 2011). Therefore, no conclusions on the achievement of objectives related to reductions in fishing mortality can be drawn given the uncertainty introduced by UR.

### Reasons for deviations

The agreed TACs have been in accordance with Article 9 of the management plan since the implementation of the plan in 2009. In the absence of reliable forecasts the TAC was reduced by 25% in 2009 and 2010 (Table 1). In 2011 the TAC was reduced more than required by the plan (-50%). The agreed TACs, however, were above ICES advice. ICES advice was in all three years based on the precautionary approach only and aimed for zero catch (no directed fishery in 2011). STECF agreed with ICES advice for 2009, 2010 and 2011, but additionally notes that the TACs based on the management plan should be 379 tons in 2010 and 284 tons in 2011 (Table 1). ICES states that a TAC constraint alone (under Article 9) is not precautionary. However, STECF notes that under article 12 of the management plan fishing effort is adjusted by the same percentage as the TAC. In the years between 2004 and the implementation of the plan, ICES and STECF advice was always zero catch. There were reductions in TAC also before the implementation of the plan, however, the reductions seem not to be based on general rules. Since no short term forecasts were conducted after 2004, no implied changes in F and SSB according to short term forecasts were analysed.

Total removals (landings * scaling factor) estimated by the stock assessment decreased over time but increased slightly between 2009 and 2010 (Figure 2). The proportion of landings in total removals declined substantially over the last years, i.e. further declined since 2008 (Figure 3). In 2010 landings were only responsible for 12% of estimated total removals. Therefore, the TAC alone cannot restrict removals from the stock according to the assessment with UR. As already mentioned, the proportion of the fisheries (discard, high grading, black landings) and biological (migration, natural mortality) factors cannot be specified making unallocated removals to a black box and a serious problem for achieving objectives of the plan.

### Conclusions

Whether the objectives of the plan in terms of reductions in fishing mortality are met cannot be answered due to the uncertainties introduced by unallocated removals. However, SSB is in any case still well below Blim and the slight increase in SSB between 2010 and 2011 has to be approved in the next assessment as estimates for the final year are always most uncertain. In addition, from one data point it cannot be deduced whether this is the beginning of a positive trend. There is no positive trend for recruitment and the 2010 year class is among the lowest ever observed. Therefore, it can be concluded that the plan had so far no positive effects on the stock. With regard to total removals also no positive effect is obvious. Estimated total removals increased slightly between 2009 and 2010 and the proportion of landings in total removals further declined since 2008. However, it is also unknown whether unallocated removals are associated with fisheries or biological factors.

## 3. North Sea cod

### Achievement of objectives

An analytical assessment of this stock was carried out in 2011 (ICES WGNSSK 2011). This assessment estimates the historic stock abundance and fishing mortality including the uncertainty about these estimates given the data. The median estimates of the stock development are used in the analyses below. The uncertainty around these values should be taken into account. According to the 2011 assessment, fishing mortality declined since 2000, but it is estimated to be well above the level that achieves the long-term objective of maximum yield (0.19) and the target of the current management plan (0.4; Figure 4). The fishing mortality in 2010 (0.68) is estimated to be above $F_{pa}$ (0.6) and to be 20% lower than F in 2004 but only 3% lower than F in 2008. Although the estimate of F 2010 might be biased as the SAM assessment model reacts slow to changes, the reduction in F over the last years mainly occurred before the new cod management plan was implemented. In addition, the reduction since 2008 is well below the intended reduction in the plan (intended F2009= 75% of F2008; intended F2010=65% of F2008).

SSB has increased since its historical low in 2006 (29437 t), but remains (54721 t) below Blim (70000 t; Figure 4). SSB increased by 86% since 2006 and by 29% since 2008. Recruitment since 2000 is poor and without obvious trend (Figure 4). The 2005 and 2009 year classes are slightly stronger but still well below historically observed recruitments.

### Reasons for deviation

In the years before the implementation of the current management plan, ICES advice was based on the precautionary approach since ICES concluded that the old cod recovery plan (EU 2004) was not consistent with the precautionary approach. The plan did not include an adaptive element implying that fisheries for cod remain closed until an initial recovery of the cod SSB has been proven. Therefore, the agreed TACs since 2004 were always above ICES advice, but in line with STECF advice in 2008

(Table 1). The estimation of implied changes in F and SSB from the short term forecasts was not straight forward for these years. Before 2007 no short term forecast was presented in the advice. Only total removals were presented in the forecasts for 2007 and 2008 TAC advice, but no landings, discards and unallocated removals separately. Under the assumption that future proportions of landings, discards and unallocated removals are the same as the average over the last three available data years, the TACs would imply strong reductions in F and substantially increased SSB (Table 1). However, ICES states in those years that future proportions could be predicted.

For 2009 ICES and STECF advice was outdated since the management plan was agreed in December of 2008 after the advice was published. However, it was stated in the 2009 ICES Advice that unallocated removals were no longer considered significant for the North Sea cod. Therefore, the final TAC decision in 2009 was most likely based on the rational that the target F of the management plan (0.4) would be reached in 2009 as predicted in the short term forecast carried out in 2008 (Table 1) and that there are no unallocated removals during the TAC year. This implied an increase in TAC above the TAC constraint of the old (15%) and new (20%) cod plan, at the same time it was argued that the increase would reduce discards. Therefore, the TAC constraint was suspended in 2009 via the new management plan (Article 8 (5)).

For the years 2010 and 2011 the TAC was set in a way that F was predicted to decrease at least as intended by the management plan (25% in 2010 and 10% thereafter) and SSB was predicted to increase above Blim during the TAC year for 2009 to 2011 (Table 1). However, it was stated by ICES in 2009 and 2010 that this would only be valid under the assumption that the management plan is implemented and enforced adequately and that objectives of the plan during the intermediate year are met (ICES Advice 2009, ICES Advice 2010). Although ICES describes in the advice that this was unlikely to be achieved, the TACs for 2010 and 2011 were set under the assumption that objectives were met for the intermediate year (i.e. reduction in F during the intermediate year) and that there are no unallocated removals during the TAC year. Both assumptions turned out to be inappropriate according to the latest assessment and this is considered to have contributed to the objectives of the plan not being met.

The total removals of cod in the North sea are estimated in terms of (i) landings, (ii) discard and (iii) unallocated removals. The proportions of landings, discard and unallocated removals in total removals changed considerably over the last 10 years according to the latest assessment estimates (ICES WGNSSK 2011; Figure 5; Table 3). The proportion of landings in total removals decreased substantially between 2000 and 2007. In 2007 landings were responsible for 35% of total removals. In the last three years the proportion of landings increased and reached 56% in 2010. The proportion of discard was less than 17% between 2001 and 2006, but increased to above 30% in 2007 and 2008. In 2009 and 2010 the proportion of discard decreased again and is estimated to be around 21% in 2010. This reduction coincides with the implementation of the management plan in 2009. Unallocated removals comprise an important part in total removals from the stock. Its proportion peaked in 2003 (47%) and decreased afterwards. Since 2009, however, the proportion is stable at around 23%. Despite a first success in reducing the proportion of discard and unallocated removals, the TAC alone is still not able to constrain the mortality on the stock.

## Analysis of Short term forecasts

The short term forecasts conducted by the working group in the years 2006 to 2009 were re-run using the estimates of fishing mortality determined from the most recent (2011) assessment. Comparison of the resulting estimates of removals and SSB from these forecasts with those estimates from the 2011 assessment can provide some indication of the ability of the short term forecasts to adequately predict the future dynamics of the stock in response to the actual level of fishing mortality that has occurred in the fishery.

Using the stock parameters from the 2010 assessment and the estimated population numbers and fishing mortalities derived from each of the annual assessments 2006 to 2010, the short term forecasts from the B-Adapt assessments were re-calculated. This approach assumes that any changes or corrections made, during the assessment year, to the biological parameters of previous years (eg. weights at age) are negligible. With the exception of a substantial revision of natural mortality estimates in 2009, this was generally the case.

### The forecast procedure

The B-Adapt forecasts are based on 1000 bootstrap estimates of terminal values for fishing mortality and population number. Each bootstrap estimate is taken forward in time, given the forecast assumptions of 3 year means for weight at age, natural mortality, maturity, etc. The exploitation pattern was taken as the average of the last 3 years, re-scaled to the fbar (2-4) of the final year. The forecast projected forward using total F to give total catches. These total catches were then split into landings and discard components using the landings fraction, by weight in the final year. Recruitment values were drawn randomly from the recent time series (1998 to last data year).

The stochastic forecasts conducted by the assessment working group were run in conjunction with, and as part of, the stock assessment software B-Adapt. The forecasts required for this exercise needed to be run with alternative assumptions of fishing mortality and it was therefore necessary to first recreate the original B-Adapt forecasts before re-running them with the alternative settings. Comparative plots of the results of the WG forecasts and of the same forecasts conducted using an FLR implementation (Figures 6 to 9) show that the values are pretty close, although not quite exact. For many of the estimates the differences in the median values between the two methods were typically around 1-2%, but could be higher in some instances. For the 2006 assessment, estimates of catch in 2006 and 2007 are almost exactly the same but differ by around 4% in 2008. Estimates of SSB also differ slightly and appear to show a cumulative under-estimation of about 1.5% per year, leading to an under-estimation of about 4.5% in 2008. Comparison of the 2008 forecast shows very close agreement for estimates of landings in 2008 and 2009 and for SSB in 2009 and 2010 but some slight differences in estimates of discards in 2008 (4.1%) and 2009 (1.3%).

The B-Adapt forecasts are stochastic and therefore almost impossible to replicate exactly. The differences noted between the two sets of results may in some cases simply be due to random variablility. But this is unlikely to be the case for all of the differences. For example, in the case of the SSB estimates for the 2006 forecast, re-running the forecast procedure several times produced the same, small but consistent under-estimation of SSB compared to the WG values indicating that the differences were due to a small, persistent bias rather than random variation. In all cases, the differences in median estimates between the two methods were less than 5% and were therefore considered to be an appropriate basis for the calculation of alternative fishing mortality scenarios.

### Alternative Forecast Results

Estimates of total removals and SSB from the short term forecasts conducted in 2006 to 2009 for those fishing mortality scenarios in accordance with the management/recovery plans (figure 10) show that for the reduced F levels, total removals from 2007 onwards would have been lower than those estimated by the 2011 assessment with corresponding SSB levels from 2008 onwards at a higher level. The level of bias in the over-estimation of future SSB is approximately equal to the under-estimation of fishing mortality (figure 10) whilst total removals appear to be either relatively well predicted or else predicted to be substantially lower than the observed values. Bias in the estimates of SSB peaked for the 2007 short term forecast and have subsequently declined. This bias may be a consequence of the large 2005 year-class, which has been successively revised in recent assessments, although the full effect of this is not entirely clear.

When the fishing mortality values are replaced with the estimates derived from the 2011 assessment the level of bias in removals and SSB is dramatically reduced, but is not removed completely (figure 11). Predicted SSB from the forecast continues to be greater than that estimated by the 2011 assessment, but also, with the higher F values, predicted removals are also estimated to be higher.

## Conclusions for North Sea cod

It has to be concluded that the effect of the management plan on the North Sea cod stock remains unclear. Positive trends in fishing mortality and SSB started well before the plan was implemented but continued after the implmenation of the plan. The reductions in F in 2009 and 2010 were marginal and are statistically not significant given the uncertainty around the point estimates (Figure 4). Intended reductions in F could not be achieved and SSB is still below $B_{lim}$. The slightly stronger 2009 year class is most likely caused by environmental variability.

The agreed TACs were set in accordance to advice based on the management plan since its implementation. In all years since 2009 forecasts predicted positive changes in F and SSB as intended by the management plan but only if the plan is implemented and enforced adequately and that reductions in F are achieved during the intermediate year. Both assumptions turned out to be inappropriate according to the latest assessment and this is considered to have contributed to the objectives of the plan not being met.

By analysing the proportions in total removals, a first success is obvious in reducing discards in 2009 and 2010. However, unallocated removals still play an important role although their proportion decreased since 2003. No further reduction in the proportion of unallocated removals is estimated since the implementation of the plan. TACs alone are still not able to restrict total removals.

Replacing the fishing mortality levels with those estimated by the 2011 assessment yielded forecast results that were closer to the estimates of total removals and SSB derived from the 2011 assessment (figure 11). This would indicate good internal consistency of the forecast procedure and would suggest that, had the fishing mortality levels implied by the management plan been implemented the stock status would be more similar to those estimates of SSB presented in figure 10 and 11. But it should be noted that the original forecasts carried out by the working group appear to underestimate the level of fishing mortality that is required to achieve the removals that have been observed in the fishery. In other words, a higher fishing mortality is required to achieve the level of removals indicated in the short term forecasts.

The performance and use of the STF to predict removals from NS cod from 2006 onwards is illustrated in Figure 12 and Table 4. Throughout this period ICES provided warning of the uncertainties in the forecast highlighting both the uncertainty in discards rates and predicting the magnitude of unaccounted removals. There is strong evidence that the EU-Norway set TACs according this short term forecast and therefore the F implied by the EU-Norway TAC (Table 4) can be inferred as the objective for managers in recent years. Bas the TACs were set according to advice and removals were similar to predicted values (Figure 12) in general the ICES STF estimated the ratio of total removals to TAC fairly well. However, the STF provided a biased prediction of out-turn F and SSB (as discussed above errors in SSB and F were of similar magnitude). If we consider the target of the plans was to achieve a target F it would be helpful to understand what caused the differences between prediction and outcome.

The most obvious cause of the difference between estimated and out-turn F in recent years is that recruitment has been revised downwards, particularly the 2005 year class which has been revised downwards to only 54% of it was first estimated value. A similar effect occurred with the 1996 year class, which has effectively been revised downwards by about 58% (though the assessment and STF were not the quite the same as they have been recently). The downward revision of R from 2003 to the present has on average been to 70% of first observations. This revision compares to revision in SSB by much more modest amounts, to 88% of initial observations over the same period. So revision is occurring most at younge ages and mostly for bigger year classes. Two possible explanations could be considered.

The survey tends to overestimate year classes and relatively more for larger year-classes, a non linear effect due to abundance dependent catch rates or interaction between survey and stock space.

Mortality on these large year classes is higher than the assessment predicts and more so than for other year classes, possibly because they have a wider distribution and are caught as non target bycatch to a greater extend.

In either case (or due to a combination of both) the consequence has been advice that suggested higher than appropriate removals to achieve the desired F. This affect appears to be reducing for current, lower, recruitment. If this reduction in bias continues the STF may be suitable for status quo levels of recruitment but is possibly less suited for occasional higher values. Overall however, there must be some doubt whether STF of the type provided by ICES are the best basis to formulate catch advice.

If the multi-annual plan were to be revised some thought should be given to how catch advice should be given. Intrinsically STFs increase measurement error, compared with assessment error, but includes more uptodate information, but if the increase in error exceeds the improved information content it would be better to base decisions on the estimated stock status not a STF. As historically SSB has been revised by -12% compared to a -30% revision for recruitment the use of a harvest rate based on assessment year SSB might have lead to better advice that using a STF.

Next to this, the TACs since 2009 were set based on forecasts assuming that the objectives of the plan are met in the intermediate year and that no unallocated removals occur during the TAC year. Both turned out to be wrong and this is considered to have contributed to an overestimation of SSB increase and F reductions that can be achieved at a certain TAC.

## Mixed-fisheries considerations for North Sea cod

### Introduction and approach

The hindcasting analyses above have demonstrated that the largest deviations between the annual advice, based on a two years forecast on the last assessment year, mainly come from the inability to correctly predict the F. The combination of a noisy B-Adapt assessment, with large year-to-year variability in estimated F, as well as an advice based on the strict implementation of the management plan assuming drastic reduction in F during the intermediate year have lead to forecast not in line with the actual F as measured in 2011.

It is important to underline that these assumptions of the forecast have repeatedly been challenged by replacing them in a broader mixed-fisheries and fleet-based context, and that this context could explain a large part of the discrepancies between forecast and reality.

Implicitly, a TAC assumes that the level of fishing activity will adapt to the quota available for a particular stock, and will lead to the targeted level of fishing mortality. The simplest link is to assume that vessels will stop catching a given species once their quota for that species is exhausted. This assumption is though little likely to hold true for complex, multispecies, multigear fisheries, where fleets are given a set of different fishing opportunities for the various stocks. Different catch limits for the various stocks may lead to imperfect implementation of the single-species TAC through incentives for misreporting, high-grading and discarding. The recent history of the North Sea cod is actually a very good example of the problems of using TACs to manage mixed fisheries. Around 2005-06, the North Sea cod stock was at a its lowest level whereas the stock of haddock, which is to a large extent caught together with cod, was at its highest biomass in 30 years (ICES, 2009b). In these circumstances, if single-species TACs are set with no consideration of the status of the other stocks caught in the same fishery, fishers are faced with a dilemma when the quota for cod is exhausted: stop fishing and underutilize the quota for haddock, or continue fishing and discard or illegally land overquota cod. When they choose the latter option, the cod TAC does not achieve its intended conservation objective. Moreover, the reliability of the assessment of the cod stock is jeopardized because the catch data on which it is based tend to become more uncertain as a result of discarding or non-reporting of landings (Reeves and Pastoors, 2007; Hamon *et al.*, 2007).

To shed light on the consistency of single species TACs within a management area a simple approach using existing catch and effort information was developed, estimating catch potentials for distinct fleets (groups of vessels) and métiers (type of activity), and hence quantifying the risks of over- and underquota utilization for the various stocks. This method, named Fcube (Fleet and Fisheries Forecast, Ulrich et al., 2011), was applied successfully to the international demersal fisheries in the North Sea and incorporated into the advice framework. This allowed ICES to provide insights on the relevancy of the North Sea cod forecast and advice in both 2009 (ICES WKMIXFISH and AGMIXNS 2009) and 2010 (ICES WGMIXFISH 2010).

Overall, the results were obvious, pointing out that the expected effort reductions during the intermediate years of the forecast both in 2009 and 2010 were not likely to be achieved under current conditions of effort, and that the required effort reductions to achieve the objectives of cod F reductions could lead to substantial underutilisation of TACs on all other stocks.

The method assumes constant fleet specific catchabilities on the different stocks and constant relative effort between metiers within each fleet going forwards in time and each year, a number of scenarios are run, of which 3 are of interest for the current evaluation:

- cod: The underlying assumption is that all fleets set their effort at the level corresponding to their cod quota share, regardless of other stocks.
- sq_E: The effort is simply set as equal to the effort in the most recently recorded year for which there is landings and discard data.
- Ef_Mgt: The effort in métiers using gears controlled by the EU effort management regime have their effort adjusted according to the regulation (see Council Regulation (EC) No 1342/2008), i.e. -25% in TR1 and TR2 effort in 2009, and additional 10% for each successive years.

No tables or figures are presented here, as all results are available in ICES (2009, 2010), but only the relevant narrative extracted from these reports is given below.

### 2010 advice

In 2009 (TAC advice 2010), The target F for the intermediate year 2009 in the individual single-stock forecasts implied a F reduction of 25%, 11% and 5% for cod, haddock and saithe respectively. Considering the **cod** scenario, the mixed fisheries analyses indicate that the 25% reduction in F required for cod also implies that the catch potential for other species, notably plaice and sole, would be undershot by 15 to 25% also. If the 25% reduction in the gears TR1 and TR2 would be applied in 2009 (Ef_Mgt scenario), this would lead to lesser reductions of potential catch for some species (especially sole), but comparatively stronger impact on catch potentials for haddock, whiting and Nephrops. Assuming again that there should be no overshoot of the cod TAC in 2010 (cod scenario) or that the effort reductions would be adhered to (Ef_Mgt) would have implied strong reductions in effort, leading to potential TAC undershoot between 15 and 40% for the other stocks compared to the single-stock forecast.

STECF estimates that between 2008 and 2009, the effort decreased by only 1% in TR1 and 6% in TR2, implying a scenario closer to the sq_E scenario. Indeed, F 2009 has hardly decreased compared to F 2008 according to the latest assessment. In the MIXFISH projection, this sq_E scenario estimated the potential cod “landings” (i.e. the non-discarded part of the catches) to be 29% above the single-stock cod forecast, implying a SSB at the start of 2010 22% lower than suggested. Accounting for this in the single-stock cod forecast would have required adjusting the 2010 TAC down by a further 20% to 31 kt instead of 38 kt.

### 2011 advice

In 2010 ICES provided advice according to both the long term management plan and the $F_{MSY}$ framework, and both lines of advice were tested in the mixed fisheries framework. Status quo F was assumed for all stocks for the intermediate year (2010) in the single-stock forecasts under the MSY Advice Approach. In the MP Advice Approach, a 13% F reduction was applied to cod.

Differences in outcomes from the scenarios considered were noticeably smaller than found the previous year indicating greater consistency both across the individual single-stock forecasts and advice and between the single stock TACs and the **sq_E** scenario. However, the cod scenario always gave the lowest catch potentials for all stocks, indicating again that the cod stock is the most limiting stock for 2011, and that reductions in effort are needed if the cod advice is to be followed. The **Ef_Mgt** scenario implied large effort reductions in 2010 in the main cod metiers (TR1, TR2 and BT2; beam trawls 80-120 mm), and this was expected to have a considerable impact on the catch potential of all other stocks considered (15 to 30% reductions). Overall, this scenario indicated a larger reduction in F in 2010 compared to the single-stock cod forecast. For the TAC advice in 2011, strict implementation of the simulated effort reductions would bring the fisheries to a level (estimated Fbar=0.45) almost equivalent to the expectation of the cod management plan (target F=0.44), but with potentially large catch undershooting for all other stocks compared to the single-stock advice (around 40% undershoot for haddock and plaice, 60% for all Nephrops and 20-30% for sole and saithe).

### Conclusion for 2011

The previous analyses had shown that if the forecasted F had been predicted more accurately compared to its estimated realization, the North Sea cod forecast would be able to predict catches and removals within an acceptable margin.

Furthermore, based on the 2011 F estimates for the time series, there seems to be a fair correlation between the decrease in F and the decrease in effort in the main gear categories (Figure 13) between 2003 and 2009, which would imply that forecast assumptions regarding the intermediate year F could be more realistically set on the basis of known and expected changes in the effort of the main fishing fleets rather than on simple average or intended reductions stipulated by the management Plan, i.e. the forecast should preferably not assume a 25% reduction in F in the intermediate year as was done in 2009, even if the LTMP says so, unless there is evidence within the Member States that significant measures are implemented to actually reduce fishing effort or catchability.

Provisional effort figures provided to STECF suggest that effort reductions between 2009 and 2010 may have been more substantial than during the previous year (-10 to 15%), although not down to the expected level of 25% of the Ef_Mgt scenario. The level of F reduction assumed in the 2010 single-stock cod forecast was 13%. This would mean that for this year, there is potentially a chance for a better match between forecast and realized F in 2010, and thus a more accurate prediction for 2011 F.

## 4. Irish Sea Cod

### Achievement of objectives

The spawning–stock biomass has declined ten-fold since the late 1980s and is suffering reduced reproductive capacity (SSB < $B_{lim}$ of 6000 t; Figure 14). The 2010 SSB was the lowest on record (947 t). SSB has declined by 77% between 2004 and 2010 and by 45% since 2008. The 2011 SSB is estimated to increase to 2260 t (calculated from survivor point estimates). Independent estimates of SSB using the Annual Egg Production (AEMP) method give SSB estimates for cod well above the absolute values given by the assessment. The relative trends in cod SSB from the AEPM and the assessment are more consistent and both indicate very low SSB in 2010. The AEPM estimates for cod remain well below the ICES estimates for the 1970s-1980s, when catch-based estimates of SSB averaged 14kt, and are also below the limit biomass reference point (Blim) of 6kt for Irish Sea cod. All sources of fishery and survey data indicate a very steep age profile indicating high rates of mortality in Irish Sea cod

The fishing mortality estimates (including unallocated removals!) since 1988 have remained above the $F_{lim}$ value of F=1.0 and the stock has therefore been harvested unsustainably over the whole period up to 2010. There is an increase estimated for F 2009 relative to F2008 (+ 9%), but a reduction for F 2010 (-14%). However, unallocated removals play an important role in this assessment and it is not entirely clear whether unallocated mortality can be attributed to fishing mortality only. Also unallocated sources of natural mortality may cause these removals what can change the perception of fishing mortality trends completely.

Recruitment has been below average for the past eighteen years. The 2002 to 2008 year classes are amongst the smallest on record. Data show increased recruitment in 2009 compared the recent period of poor recruitment, but still below the long-term average. Preliminary indications suggest the 2010 year class is some way below the 2009 estimate. The increased recruitment in the last two years will lead to an increase in SSB in the next years from the historical low.

### Reasons for deviation

The agreed TACs have been in accordance with Article 9a of the management plan since the implementation of the plan in 2009. In the absence of reliable forecasts the TAC was reduced by 25% in 2009, 2010 and 2011 (Table 5). The agreed TACs, however, were above ICES advice. ICES advice was in all three years based on the precautionary approach only and aimed for zero catch. ICES states that the plan is not precautionary for this stock. STECF agreed with ICES advice for 2009, 2010 and 2011, but additionally notes that the TACs based on the management plan should be 674 tons in 2010 and 506 tons in 2011 (Table 5). In the years between 2004 and the implementation of the plan, ICES and STECF advice was always zero catch. There were reductions in TAC also before the implementation of the plan, however, the reductions seem not to be based on general rules. Since no short term forecasts were conducted after 2004, no implied changes in F and SSB according to short term forecasts were analysed.

Total removals (landings * scaling factor) estimated by the stock assessment decreased since 2003 but increased slightly between 2009 and 2010 (Figure 14). The proportion of landings in total removals declined substantially between 2000 and 2003 (26% in 2003; Figure 15). After 2003 the proportion of landings increased and are now around 40%. There is no further increase in the proportion of landings since 2008. Therefore, the TAC alone cannot restrict removals from the stock. The source of unallocated removals remains unclear, given the proportion of the fisheries (discard, high grading, black landings) and biological (migration, natural mortality) factors cannot be specified.

### Conclusions for Irish Sea cod

Whether the objectives of the plan in terms of reductions in fishing mortality are met cannot be answered due to the uncertainties in the source of unallocated removals. However, SSB is in any case still well below Blim. There are positive signs for increased recruitment driven by environmental factors . The next years will decide whether the management plan can avoid that the stronger year classes will be discarded. So far no positive effect is obvious in relation to total removals. The proportion of landings in total removals remained stable since 2008. However, it is also unknown whether unallocated removals are associated with fisheries or biological factors.

# 5. West of Scotland Cod

## Achievement of objectives

An analytical assessment was carried out in 2011 (ICES WGCSE 2011) but this has been rejected as the basis for advice by ICES because it relied on data from a research survey which changed ground gear and statistical design in 2011. The following statements are based on the median values of the estimates from the 2010 assessment. It has to be taken into account that there is uncertainty around these values. It is considered natural mortality is probably above the constant of 0.2 on all ages, assumed in gadoid stock assessments WoS, and with trend but the actual levels have not been quantified. As a consequence it is not considered possible to partition mortality into fishing, discard and unaccounted mortality. Instead assessment results are simply described as total mortality minus the input 0.2 for natural mortality, or 'Z-0.2'. Because the assumption for natural mortality M has remained the same since determination of F reference points, values of Z-0.2 can be considered in comparison to those reference points. According to the 2010 assessment, Z-0.2 mortality has, since the mid 1980s fluctuated around a level just above Flim. Because catch data are not used from 1995 onwards, (concerns over under-reporting) the estimate is very uncertain, however even the lower bound of the 95% confidence limit is higher than Fpa and well above the level that achieves the long-term objective of maximum yield (0.19) and the target of the current management plan (0.4; Figure 16).

Z-0.2 in 2009 (0.87) was estimated to be 6.5% lower than Z-0.2 in 2004 and 4.4% lower than Z-0.2 in 2008. The lowest estimated value of Z-0.2 since 2004, however, was for 2007 and the value of this metric has no clear trend over the period.

SSB has increased since its historical low in 2006 (3573 t), but remained below $B_{lim}$ (14000 t) in 2010 at 6227 t; (Figure 16). SSB increased by 74% since 2006 but was estimated to have fallen by 5.4% from 2008 to 2010. An increase from the 2008 value to the projected 2011 value of 16% was predicted. As in the North Sea, recruitment since 2000 is poor with no obvious trend. The 2005 and 2008 year classes are stronger than the norm over the last decade but still well below historically observed recruitments (Figure 16).

## Reasons for deviation

The current cod management plan has not been accepted as precautionary for the WoS cod stock for the reason that to date it has not been possible to assess unaccounted mortality accurately. The previous cod recovery plan was also not accepted as precautionary because "ICES is not in a position to give quantitative forecasts and can therefore not evaluate the management plan and provide upper bounds to a TAC". Based on the precautionary approach ICES has recommended zero catch since the advice for 2003. For advice from 2004 onwards STECF either explicitly or implicitly agreed with the advice for zero catch.

As for the North Sea the STECF advice for the 2009 TAC became outdated once the new management plan was agreed in December of 2008 after advice was published. STECF agreed with ICES that catches should be zero. The TAC was reduced by 40%. Using the short term forecast of the 2008 ICES assessment (not presented in the advice sheet) that assumed all mortality over M to be due to fishing, this level of removals would lead to a 92% increase in SSB for 2010, well in excess of the 30% required by article 6.2 of the old management plan, although article 7b of that plan allowed for lower TACs to be set if a 30% increase did not result in SSB above Blim at the end of the TAC year (true in this instance).

The TACs for 2010 did not change for area VIa and Vb (EU) compared to 2009. STECF agreed with ICES that no fishing should take place on cod in VIa and both organisations considered that if the management plan were applied article 9a would need to be invoked (stock considered data poor and there is advice for reduction of catches to the lowest possible level) leading to a 25% cut in TAC. The final TAC was 240 t compared to 180 t if article 9a were invoked. Although unconfirmed, it is possible the 2010 TAC resulted from an administrative error. Up to and including the advice for 2009 TACs, the TAC for areas VIa and Vb (EU) was declared as part of a larger TAC for areas VI, Vb EU, XII and XIV. From 2010 the TAC for VIa and Vb (EU) continued and a TAC for VIb (Rockall), VII and XIV was declared separately (Table 6.8.2). The difference between the larger area TAC for 2009 and the VIa-Vb TAC for 2010 is 21%. The 2011 TAC was set approximately in line with article 9a of the management plan; 24% reduction vs. 25% in plan (Table 6).

ICES advice for several years (e.g. 2005) has highlighted the technical interaction between vessels fishing for other gadoids (haddock and whiting) and Nephrops. In 2005 ICES also highlighted the high discarding rate of cod. The recorded rate of discards became considerably higher from 2006 (Figure 17) and discarding was observed at older ages (including ages 3 and 4 compared to only ages 1 and 2 previously), suggesting new legislation to eliminate under-reporting introduced in that year had been successful. The concerns over under-reporting in earlier years mean commercial data has been excluded from the stock assessment from 1995. Estimated total removals rose to be – by the mid 2000s - considerably above landings plus raised discards, even taking into account the significant increase in recorded discards (Figure 18). The discrepancy has reduced in more recent years but is still significant.

The effort limits and catch composition rules associated with the management plan WoS are only in effect for part of the stock area. For vessels of length 15m and over operating west of a management line shown in Figure 19 effort is restricted to a lesser degree. Figure 19 also shows locations of fishing activity using TR1 gear (from VMS data) linked to cod landings (Scottish vessels). It can be seen a large proportion of the effort falls outside of the cod management area.

Estimates of cod consumed by grey seals to the west of Scotland by the Sea Mammal Research unit (SMRU, 2006) suggest predation mortality on cod is greater than can be accommodated by the standard value of natural mortality used for gadoid species WoS. Estimates of increasing seal population also suggest there may be a trend in this predation mortality.

### Conclusions for WoS cod

The situation is similar to Irish Sea cod in that it is not possible to answer whether the objectives of the plan in terms of reductions in fishing mortality are met because of uncertainties introduced by unallocated removals. In the case of WoS cod the concerns about unallocated removals revolve around a suspected high level and trend in natural mortality as much as unallocated removals due to fishing. However, as pointed out by the ICES assessment, for management purposes the estimated Z-0.2 mortality would still need to fall below the level of Flim, as higher levels of mortality over and above M are considered to have led to stock decline.

It is clear that TACs have not controlled catch, with discards estimated to be several times landings in terms of bulk weight. The effort limits and catch composition rules applicable to WoS cod only apply to part of the stock area. There does, however, appear a trend of increasing SSB since 2006.

**References:**


EU 2004. Council Regulation (EC) No 423/2004 of 26 February 2004 establishing measures for the recovery of cod stocks

EU 2008. Council Regulation (EC) No 1342/2008 of 18 December 2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing Regulation (EC) No 423/2004.

ICES WKROUND. 2009. Report of the Benchmark and Data Compilation Workshop for Roundfish (WKROUND). ICES CM 2009/ ACOM:32

ICES WGBFAS. 2011. Report of the Baltic Fisheries Assessment Working Group. ICES CM 2011/ ACOM: xx

ICES WGCSE. 2010. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE). ICES CM 2010/ACOM:12

ICES WGCSE. 2011. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE). ICES CM 2011/ACOM:xx

ICES WGNSSK. 2011. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 2011/ ACOM xx


**Additional Sources:**


ICES 2010 Report of the ICES advisory committee 2010, ICES advice 2010, Book 5

ICES 2010 Report of the ICES advisory committee 2010, ICES advice 2010, Book 6

ICES 2009 Report of the ICES advisory committee 2009, ICES advice 2009, Book 5

ICES 2009 Report of the ICES advisory committee 2009, ICES advice 2009, Book 6

ICES 2008 Report of the ICES advisory committee 2008, ICES advice 2008, Book 5

ICES 2008 Report of the ICES advisory committee 2008, ICES advice 2008, Book 6

ICES 2007 Report of the ICES advisory committee on fishery management. Advisory committee on the marine environment and advisory committee on ecosystems, 2007. ICES advice, Book 5

ICES 2007 Report of the ICES advisory committee on fishery management. Advisory committee on the marine environment and advisory committee on ecosystems, 2007. ICES advice, Book 6

ICES 2006 Report of the ICES advisory committee on fishery management. Advisory committee on the marine environment and advisory committee on ecosystems, 2006. ICES advice, Book 5

ICES 2006 Report of the ICES advisory committee on fishery management. Advisory committee on the marine environment and advisory committee on ecosystems, 2006. ICES advice, Book 6

ICES 2005 Report of the ICES advisory committee on fishery management. Advisory committee on the marine environment and advisory committee on ecosystems, 2005. ICES advice, Book 5

ICES 2005 Report of the ICES advisory committee on fishery management. Advisory committee on the marine environment and advisory committee on ecosystems, 2005. ICES advice, Book 6

ICES 2004 Report of the ICES advisory committee on fishery management. Advisory committee on the marine environment and advisory committee on ecosystems, 2004. ICES advice, Book 2 (Part 2)

ICES 2004 Report of the ICES advisory committee on fishery management. Advisory committee on the marine environment and advisory committee on ecosystems, 2004. ICES advice, Book 2 (Part 1)

STECF 2010 Consolidated Review of Scientific Advice for 2011 for Fish Stocks of Interest to the European Community.

STECF 2009 Consolidated Review of Scientific Advice for 2011 for Fish Stocks of Interest to the European Community.

STECF 2008 Consolidated Review of Scientific Advice for 2011 for Fish Stocks of Interest to the European Community.

STECF 2007 Consolidated Review of Scientific Advice for 2011 for Fish Stocks of Interest to the European Community.

STECF 2006 Consolidated Review of Scientific Advice for 2011 for Fish Stocks of Interest to the European Community.

STECF 2005 Consolidated Review of Scientific Advice for 2011 for Fish Stocks of Interest to the European Community.

STECF 2004 Consolidated Review of Scientific Advice for 2011 for Fish Stocks of Interest to the European Community.

**Table 1: Overview of advice and agreed TACs for Kattegat cod in the years 2004 to 2011 in addition to implied changes in F and SSB according to short term forecasts used as basis for advice and TAC negotiations.**

| Year | ICES Advice | Rational behind ICES Advice | Agreed TAC | Change in agreed TAC | Implied F in the TAC year according to short-term forecast | F intermediate year (predicted) | Changes in F (F TAC year/ F intermediate year) | SSB after the TAC year according to short-term forecast | SSB at the beginning of TAC year (predicted) | Changes in SSB (SSB after TAC year / SSB at the beginning of TAC year) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0 [1] | Precautionary approach | 1.363 | | 0.46 | 1.35 | -66% | 3297 | 1833 | 80% |
| 2005 | 0 [1] | Precautionary approach | 1 | -27% | 0.6 | 1.46 | -59% | 3860 | 2030 | 90% |
| 2006 | 0 [1] | Precautionary approach | 0.85 | -15% | **Short-Term Forecasts conducted but not presented in the Advice** | | | | | |
| 2007 | 0 [1] | Precautionary approach | 0.731 | -14% | **Short-Term Forecast conducted but not presented in the Advice** | | | | | |
| 2008 | 0 [1] | Precautionary approach | 0.673 | -8% | **No Short-Term Forecast** | | | | | |
| 2009 | 0 [1] | Precautionary approach | 0.505 | -25% | **No Short-Term Forecast** | | | | | |
| 2010 | 0 [2] | Precautionary approach | 0.379 | -25% | **No Short-Term Forecast** | | | | | |
| 2011 | no directed fishery [3] | Precautionary approach | 0.19 | -50% | **No Short-Term Forecast** | | | | | |

[1] STECF agrees with ICES advice

[2] STECF agrees with ICES advice but also notes that TAC should be 379 tonnes based on the management plan

[3] STECF agree with ICES advice but also notes that TAC shoul be 278 tonnes based on the managment plan

**Sources: ICES advice 2003-2010; STECF review of scientific advice 2005 - 2010**

**Table 2: Overview of advice and agreed TACs for cod in IIIa west, IV and VIId in the years 2004 to 2011 in addition to implied changes in F and SSB according to short term forecasts used as basis for advice and TAC negotiations.**

| Year | ICES Advice TAC | Rational behind ICES Advice | Agreed TAC | Change in agreed TAC | Implied F in the TAC year according to short-term forecast | F intermediate year (predicted) | Changes in F (F TAC year/ F intermediate year) | SSB after the TAC year according to short-term forecast | SSB at the beginning of TAC year (predicted) | Changes in SSB (SSB after TAC year / SSB at the beginning of TAC year) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0 | Precautionary approach | 31.2 [1] | | **No deterministic forecast presented in the Advice** | | | | | |
| 2005 | 0 | Precautionary approach | 31.2 [1] | 0 | **Only provisional forecasts, Option table not presented in the final advice** | | | | | |
| 2006 | 0 [5] | Precautionary approach | 26.5 [1] | -15% | **No Short- Term Forecast presented in the Advice** | | | | | |
| 2007 | 0 [5] | Precautionary approach | 22.9 [1] | -13.50% | 0.39 [3] | 0.85 [3] | -54% [3] | 63 [3] | 35.7 [3] | 76% [3] |
| 2008 | <22 total removals [6] | Precautionary approach | 25.4 [1] | 11% | 0.27 [4] | 0.54 [4] | -50% [4] | 127.4 [4] | 62.3 [4] | 104% [4] |
| 2009 | 0 [7] | Precautionary approach | 34.6 [2] | 36% (31% if TAC 2008 is increased by 4% to include area VIId) | 0.4 | 0.58 | -31% | 94.6 | 70.7 | 34% |
| 2010 | 40.3 [5] | Management plan (F 0.65* F2008) | 40.3 [2] | 16.50% | 0.51 | 0.59 | -13.60% | 79.6 | 66 | 21% |
| 2011 | 32.2 [5] | Management plan (F 0.55* F2008) and TAC constraint | 32.2 [2] | -20% | 0.44 | 0.74 | -40.50% | 72 | 54.3 | 32% |

[1] TAC includes areas IV, IIIa

2 TAC includes areas VIId, IV, IIIa

[3] The short term forecast only estimates total removals. Discards and unallocated removals were added to the agreed TAC to find implied Fs and SSBs in the advice table under the assumption: 50% landings, 10% discard and 40% unallocated removals (Mean 2003-2005)

[4] The short term forecast only estimates total removals. Assumed discards and unallocated removals were added to the agreed TAC to find implied Fs and SSBs in the advice table under the assumption: 56% landings, 13% discard and 31% unallocated removals (Mean 2004-2006).

[5] STECF agrees with ICES assessment and Advice

[6] According to STECF TAC in II(EU), IIIa and IV excluding 7d should be less than 26229 t

[7] ICES advice and STECF advice are outdated since the managment plan was agreed after advice was published

**Sources: ICES advice 2003-2010; STECF review of scientific advice 2005 - 2010**

**Table 3. Cod in Subarea IV (North Sea), Division VIId (Eastern Channel), and Divission IIIa (Skagerrak). Reported catch (landings plus discards) and estimated removals from the 2011 SAM assessment. (ICES, 2011)**

| Year | Landings | Discards | Catch | Catch multiplier | Total Removals |
|---|---|---|---|---|---|
| 1963 | 112758 | 14118 | 126754 | | 126754 |
| 1964 | 140787 | 13837 | 154662 | | 154662 |
| 1965 | 183322 | 22181 | 205664 | | 205664 |
| 1966 | 218819 | 33456 | 252458 | | 252458 |
| 1967 | 266199 | 34648 | 301040 | | 301040 |
| 1968 | 279568 | 21703 | 301342 | | 301342 |
| 1969 | 229120 | 12585 | 241591 | | 241591 |
| 1970 | 246965 | 25034 | 271848 | | 271848 |
| 1971 | 291268 | 63070 | 353982 | | 353982 |
| 1972 | 325462 | 34372 | 359691 | | 359691 |
| 1973 | 234920 | 24810 | 259886 | | 259886 |
| 1974 | 214915 | 25135 | 240145 | | 240145 |
| 1975 | 205048 | 32177 | 237281 | | 237281 |
| 1976 | 197205 | 36425 | 233748 | | 233748 |
| 1977 | 179872 | 62380 | 242316 | | 242316 |
| 1978 | 278452 | 38754 | 317109 | | 317109 |
| 1979 | 270493 | 41940 | 312388 | | 312388 |
| 1980 | 270763 | 66237 | 337055 | | 337055 |
| 1981 | 322223 | 38216 | 360411 | | 360411 |
| 1982 | 291851 | 39895 | 331705 | | 331705 |
| 1983 | 253723 | 25160 | 278730 | | 278730 |
| 1984 | 197798 | 45844 | 243531 | | 243531 |
| 1985 | 201189 | 22248 | 223463 | | 223463 |
| 1986 | 160492 | 44445 | 204843 | | 204843 |
| 1987 | 215777 | 29437 | 245242 | | 245242 |
| 1988 | 184795 | 12640 | 197402 | | 197402 |
| 1989 | 134996 | 32338 | 167209 | | 167209 |
| 1990 | 113664 | 21397 | 135131 | | 135131 |
| 1991 | 104715 | 14464 | 119134 | | 119134 |
| 1992 | 106831 | 27011 | 133786 | | 133786 |
| 1993 | 126694 | 26148 | 152899 | 0.97 | 147561 |
| 1994 | 104349 | 35721 | 140154 | 1.08 | 150844 |
| 1995 | 122165 | 27423 | 149661 | 1.22 | 183139 |
| 1996 | 135372 | 21912 | 157280 | 1.03 | 161943 |
| 1997 | 133517 | 44090 | 177546 | 0.93 | 165049 |
| 1998 | 139145 | 41826 | 180822 | 0.77 | 139525 |
| 1999 | 101165 | 17499 | 118600 | 0.83 | 98322 |
| 2000 | 79549 | 21070 | 100622 | 1.00 | 101114 |
| 2001 | 47830 | 13156 | 60986 | 1.49 | 90853 |
| 2002 | 62941 | 7636 | 70541 | 1.26 | 88965 |
| 2003 | 27313 | 5221 | 32537 | 1.89 | 61574 |
| 2004 | 28852 | 7039 | 35916 | 1.36 | 49021 |
| 2005 | 29466 | 6005 | 35454 | 1.42 | 50262 |
| 2006 | 26001 | 7718 | 33721 | 1.37 | 46351 |
| 2007 | 22707 | 20982 | 43714 | 1.49 | 65186 |
| 2008 | 27155 | 22099 | 49233 | 1.25 | 61390 |
| 2009 | 32653 | 16798 | 49498 | 1.29 | 63831 |
| 2010 | 38963 | 14401 | 53336 | 1.30 | 69286 |

**Table 4. North Sea cod. Summary of year by year advice with removals expressed as a ratio of various values.**

| | | | Year by Year Advice | | | |
|---|---|---|---|---|---|---|
| | | | Set | STF | STF | |
| WG Year | Catch year | F Target | TAC | Catches | Removals | Rem/TAC |
| 2003 | 2004 | | 31200 | | | |
| 2004 | 2005 | | 31200 | ---- | ---- | |
| 2005 | 2006 | | 26520 | ---- | ---- | |
| 2006 | 2007 | 0.40 | 22851 | 27421 | 46700 | 2.04 |
| 2007 | 2008 | 0.27 | 25400 | 31404 | 45357 | 1.79 |
| 2008 | 2009 | 0.40 | 34590 | 54000 | 54000 | 1.56 |
| 2009 | 2010 | 0.51 | 40300 | 66400 | 66400 | 1.65 |
| 2010 | 2011 | 0.44 | 32241 | 49900 | | |

| | | Outcome | 2011 Assessment | | | |
|---|---|---|---|---|---|---|
| | F | Landings | Catches | Removals | Rem/Land | Rem/Catch |
| 2004 | 0.856 | 28852 | 35916 | 49021 | 1.70 | 1.36 |
| 2005 | 0.807 | 29466 | 35454 | 50262 | 1.71 | 1.42 |
| 2006 | 0.753 | 26001 | 33721 | 46351 | 1.78 | 1.37 |
| 2007 | 0.720 | 22707 | 43714 | 65186 | 2.87 | 1.49 |
| 2008 | 0.699 | 27155 | 49233 | 61390 | 2.26 | 1.25 |
| 2009 | 0.684 | 32653 | 49498 | 63831 | 1.95 | 1.29 |
| 2010 | 0.676 | 38963 | 53336 | 69286 | 1.78 | 1.30 |

| | | Ratio of outcome to predicted | | |
|---|---|---|---|---|
| | F | Landings | Catches | Removals |
| 2004 | | 92% | | |
| 2005 | | 94% | | |
| 2006 | | 98% | | |
| 2007 | 180% | 99% | 159% | 140% |
| 2008 | 259% | 107% | 157% | 135% |
| 2009 | 171% | 94% | 92% | 118% |
| 2010 | 133% | 97% | 80% | 104% |

**Table 5: Overview of advice and agreed TACs for Irish Sea cod in the years 2004 to 2011 in addition to implied changes in F and SSB according to short term forecasts used as basis for advice and TAC negotiations.**

| Year | ICES Advice | Rational behind ICES Advice | Agreed TAC | TAC change (%) | Implied F in the TAC year according to short-term forecast | F intermediate year (predicted) | Changes in F (F TAC year/ F intermediate year) | SSB after the TAC year according to short-term forecast | SSB at the beginning of TAC year (predicted) | Changes in SSB (SSB after TAC year / SSB at the beginning of TAC year) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0 | Precautionary approach | 2.15 | | 0.515 | 1.47 | -65% | 5950 | 4600 | 29% |
| 2005 | 0 | Precautionary approach | 2.15 | 0 | 0.71 | 1.03 | -31% | 4180 | 3220 | 30% |
| 2006 | 0 [1] | Precautionary approach | 1.828 | -15% | **No precise Short-Term Forecast presented in the Advice** | | | | | |
| 2007 | 0 [1] | Precautionary approach | 1.462 | -20% | **No precise Short-Term Forecast presented in the Advice** | | | | | |
| 2008 | 0 [1] | Precautionary approach | 1.199 | -18% | **No Short-Term Forecast** | | | | | |
| 2009 | 0 [1] | Precautionary approach | 0.899 | -25% | **No Short-Term Forecast** | | | | | |
| 2010 | 0 [2] | Precautionary approach [4] | 0.674 | -25% | **No Short-Term Forecast** | | | | | |
| 2011 | 0 [3] | Precautionary approach [4] | 0.506 | -25% | **No Short-Term Forecast** | | | | | |

[1] STECF agrees with ICES advice

[2] STECF agrees with ICES advice but also notes that TAC should be 674 tonnes based on the management plan

[3] STECF agree with ICES advice but also notes that TAC shoul be 506 tonnes based on the managment plan

[4] ICES states that the plan is not consistent with the precautionary approach for this stock

**Sources: ICES advice 2003-2010; STECF review of scientific advice 2005 - 2010**

**Table 6: Overview of advice and agreed TACs for WoS cod in the years 2004 to 2011 in addition to implied changes in F and SSB according to short term forecasts used as basis for advice and TAC negotiations.**

| Year | ICES Advice | Rational behind ICES Advice | Agreed TAC (t) | Change in agreed TAC | Implied F in the TAC year according to short-term forecast | F intermediate year (predicted) | Changes in F (F TAC year/ F intermediate year) | SSB after the TAC year according to short-term forecast | SSB at the beginning of TAC year (predicted) | Changes in SSB (SSB after TAC year / SSB at the beginning of TAC year) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0#1 | Precautionary approach | 814 (848)#4 | | 0.37 | 1.01 | -63% | 3213 | 2170 | 48% |
| 2005 | 0#2 | Precautionary approach | 692 (721)#4 | -15% | **Short-Term Forecasts (landings and discards) - three alternative final assessments - conducted but not presented in the Advice** | | | | | |
| 2006 | 0#2 | Precautionary approach | 588 (613)#4 | -15% | **Short-Term Forecast (total removals) - using SURBA - conducted but not presented in the Advice** | | | | | |
| 2007 | 0#1 | Precautionary approach | 490 (556)#4 | -17% | **Short-Term Forecast (total removals) - using SURBA - conducted but not presented in the Advice** | | | | | |
| 2008 | 0#1 | Precautionary approach | 402 (447)#4 | -18% | **Short-Term Forecast (total removals) conducted but not presented in the Advice** | | | | | |
| 2009 | 0#1 | Precautionary approach | 240 (302)#4 | -40% | **Short-Term Forecast (total removals) conducted but not presented in the Advice** | | | | | |
| 2010 | 0#3 | Precautionary approach | 240 (80)#5 | 0% | **Short-Term Forecast (total removals) conducted but not presented in the Advice** | | | | | |
| 2011 | 0#3 | Precautionary approach | 182 (78)#5 | -24% | **Short-Term Forecast (total removals) conducted but not presented in the Advice** | | | | | |

#1 STECF agreed with ICES advice
#2 STECF only noted 'critically low level' of VIa cod
#3 STECF agrred with ICES advice (both organisations also agreed article 9a should be used if the management plan is applied)
#4 TAC for VIa and EU waters of Vb declared as part of TAC for VI, EU waters of Vb and XII and XIV (larger TAC given in brackets)
#5 TAC for VIa and international waters of Vb east of 12 degrees W (TAC for VIb and Vb west of 12 degrees west and XII and XIV given in brackets)
**Sources: ICES advice 2004-2010; STECF review of scientific advice 2003 - 2010**

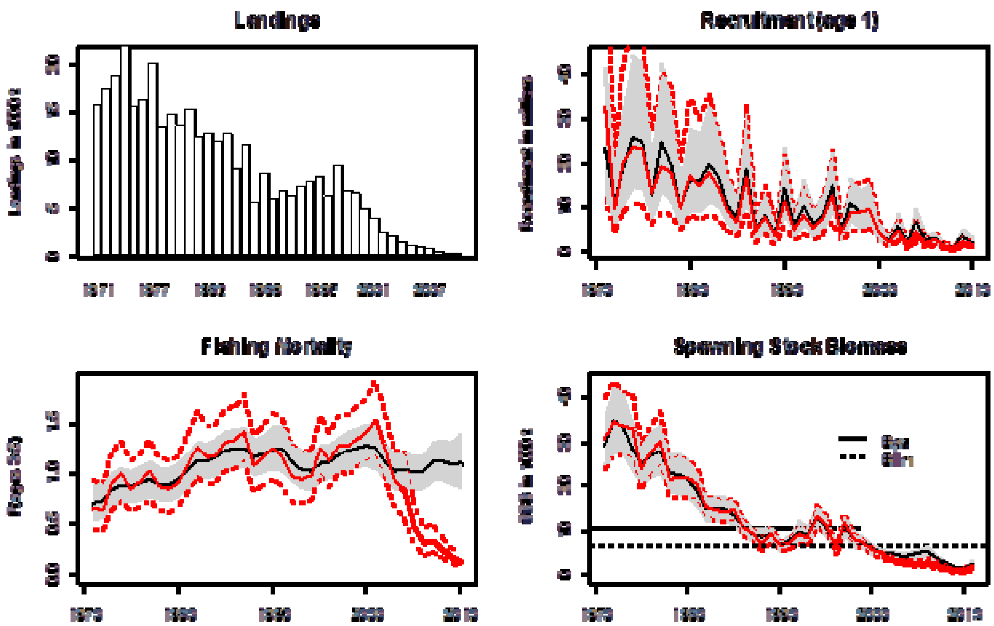


**Figure 1: Summary of cod in the Kattegat stock assessment (weights in '000 tonnes) represented by two runs with (black line) and without (red line) estimating unallocated removals. Shaded area and broken lines represent 95% confidence intervals for the runs with and without estimating unallocated removals, respectively.**

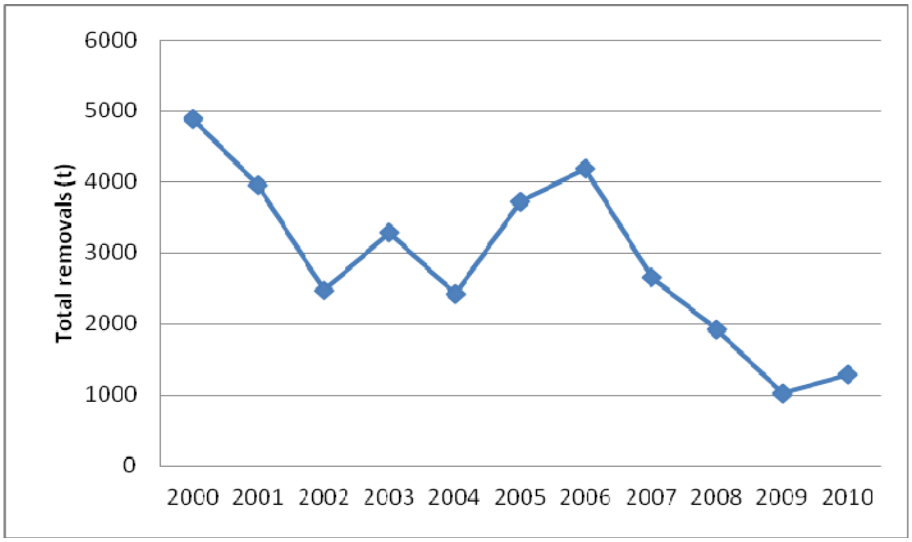


**Figure 2. Total removals from the Kattegat cod stock between 2000 and 2010 as estimated in the 2011 assessment (ICES WGBFAS 2011)**

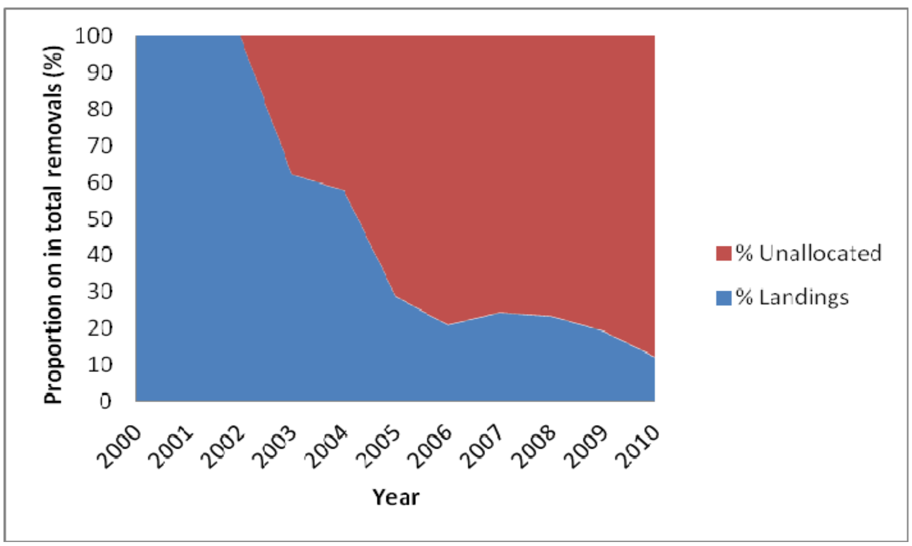


**Figure 3. Proportion of landings and unallocated removals in total removals as estimated for Kattegat cod in the years 2000 – 2010.**

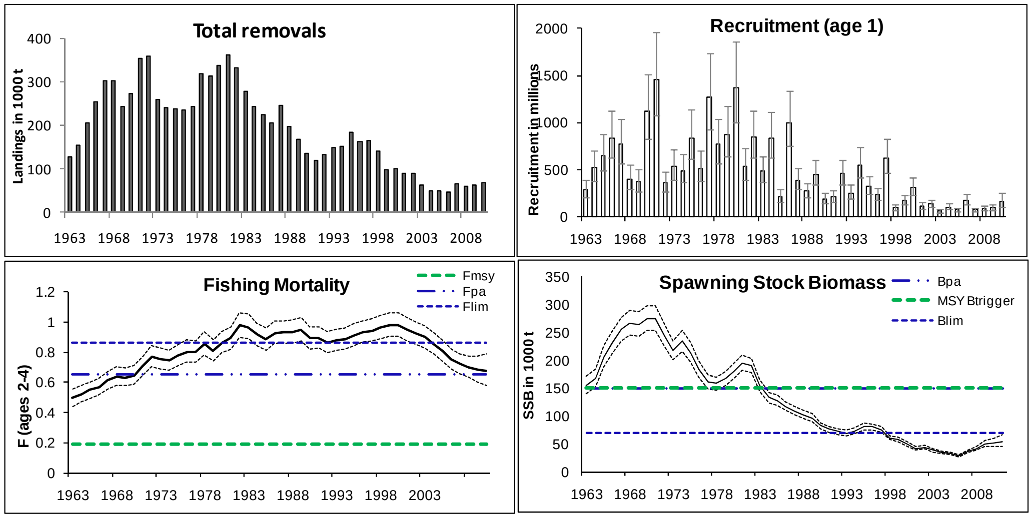


**Figure 4: Cod in Subarea IV (North Sea), Division VIId (Eastern Channel), and IIIa West (Skagerrak). Summary of stock assessment with point-wise 95% confidence intervals, catch estimated, and adjusted for unallocated removals (from 1993), weights in tonnes**

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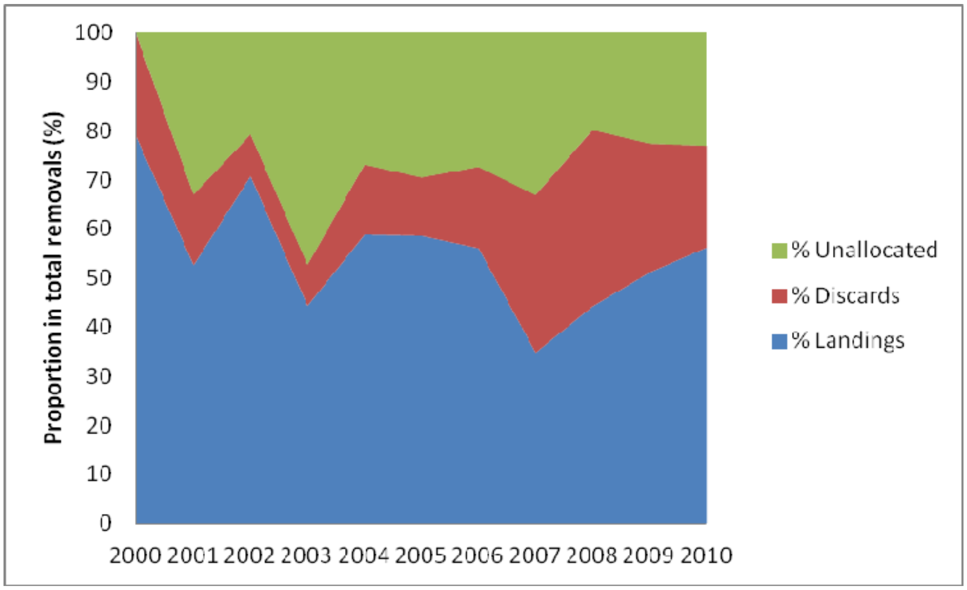


**Figure 5: Proportion of landings, discards and unallocated removals in total removals in the last 10 years for cod in IIIa west, IV and VIId.**

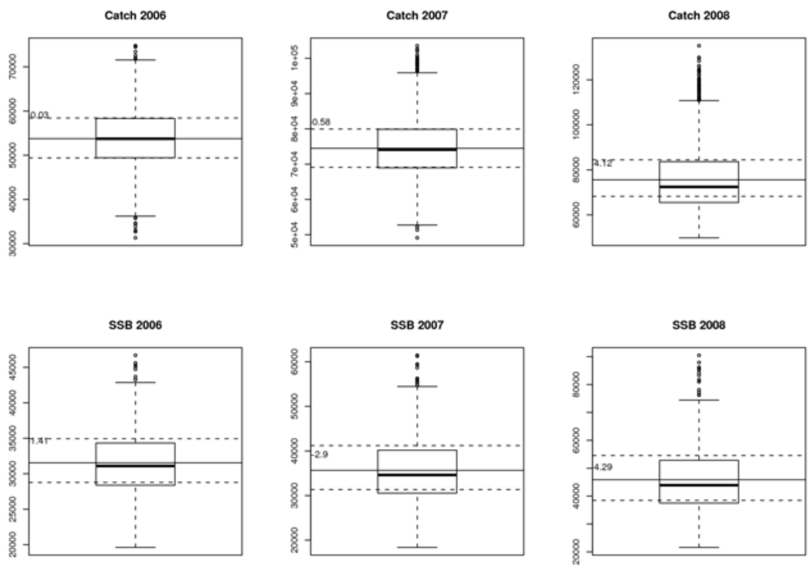


**Figure 6. 2006 Stochastic Short term forecast. Comparison of B-Adapt and R script analyses. Box-plots show the median, 25th and 75th quantiles with whiskers extending to to the most extreme data point less than 1.5 times the interquartile range. Horizontal lines show the median 25th and 75th quantiles for the WG estimates.**

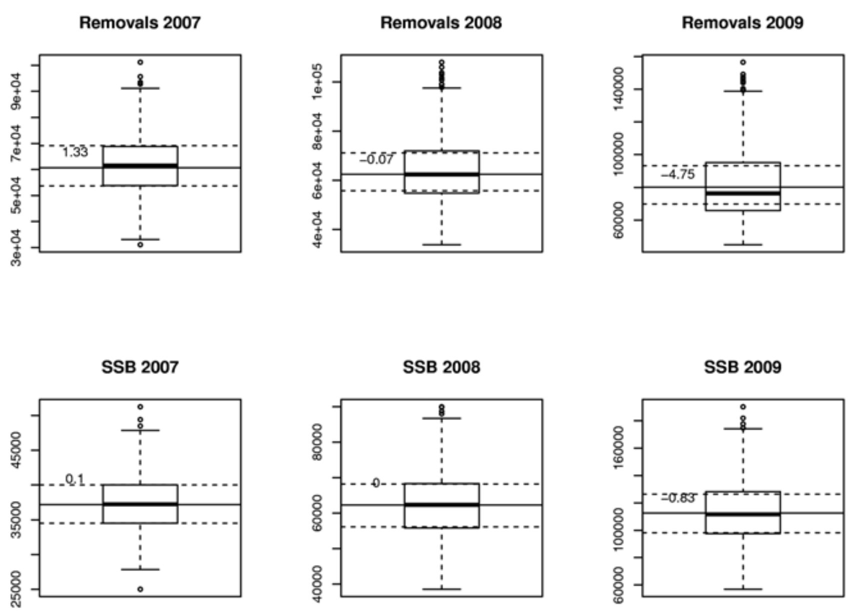


**Figure 7. 2007 Stochastic Short term forecast. Comparison of B-Adapt and R script analyses. Box-plots show the median, 25th and 75th quantiles with whiskers extending to to the most extreme data point less than 1.5 times the interquartile range. Horizontal lines show the median 25th and 75th quantiles for the WG estimates**

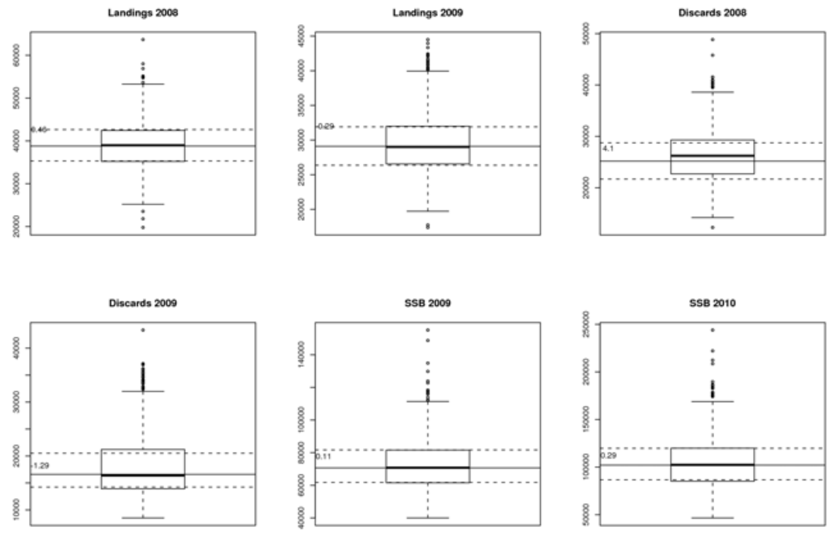


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**Figure 8. 2008 Stochastic Short term forecast. Comparison of B-Adapt and R script analyses. Box-plots show the median, 25th and 75th quantiles with whiskers extending to to the most extreme data point less than 1.5 times the interquartile range. Horizontal lines show the median 25th and 75th quantiles for the WG estimates.**

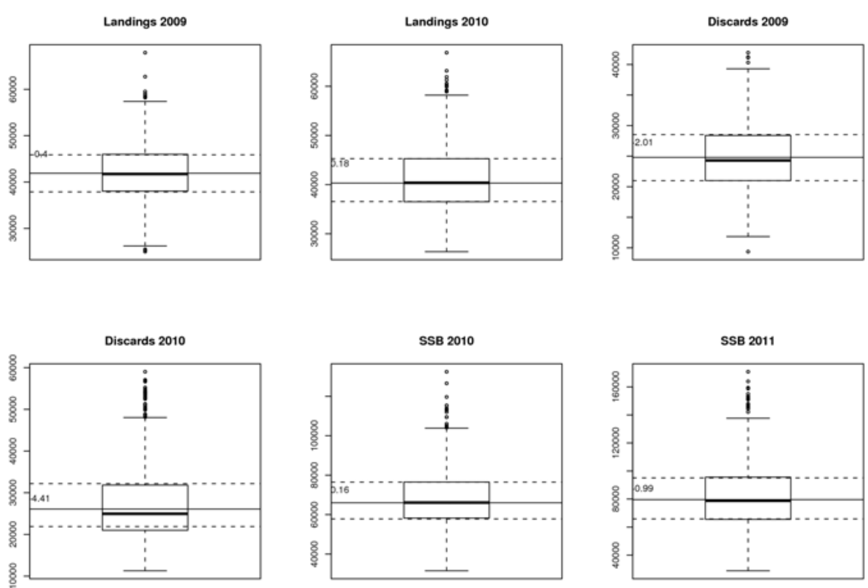



**Figure 9. 2009 Stochastic Short term forecast. Comparison of B-Adapt and R script analyses. Box-plots show the median, 25th and 75th quantiles with whiskers extending to to the most extreme data point less than 1.5 times the interquartile range. Horizontal lines show the median 25th and 75th quantiles for the WG estimates.**

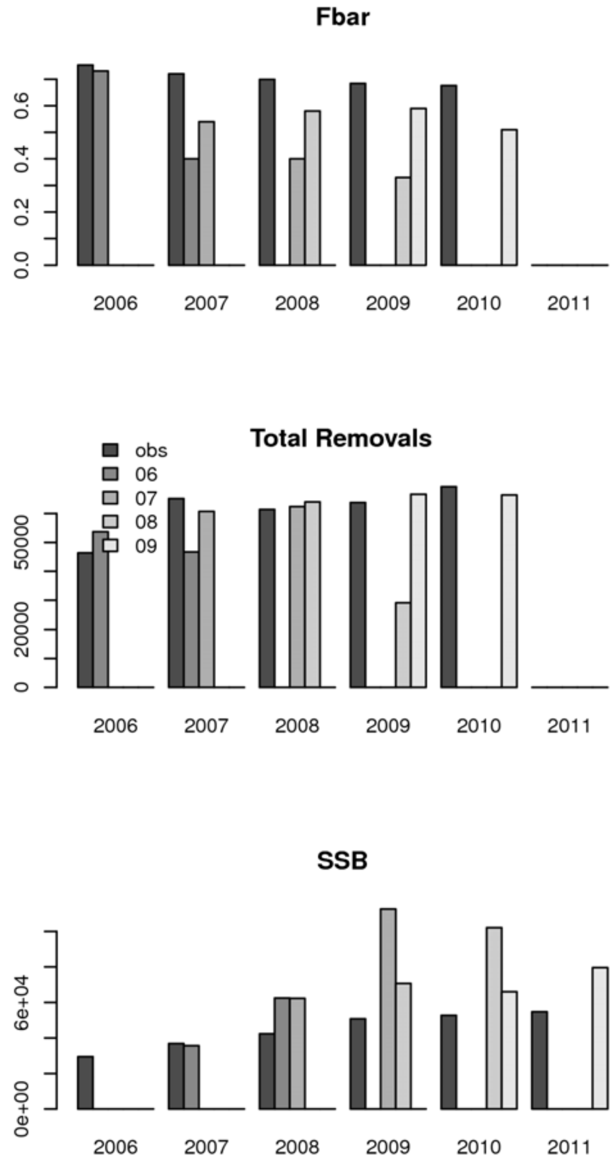



**Figure 10. Estimated total removals and SSB for the years 2006 to 2011, determined from the short term forecasts for 2006 to 2009 as conducted by the WG. Values are taken from the options corresponding to the management plan. Forecast options in accordance with the management plan were not presented in the 2007 advice sheet. Values are taken instead from the WG report. The 2011 assessment estimates are shown in dark grey. The Estimates from the 2006, 2008 and 2009 forecasts are shown in lighter shades.**

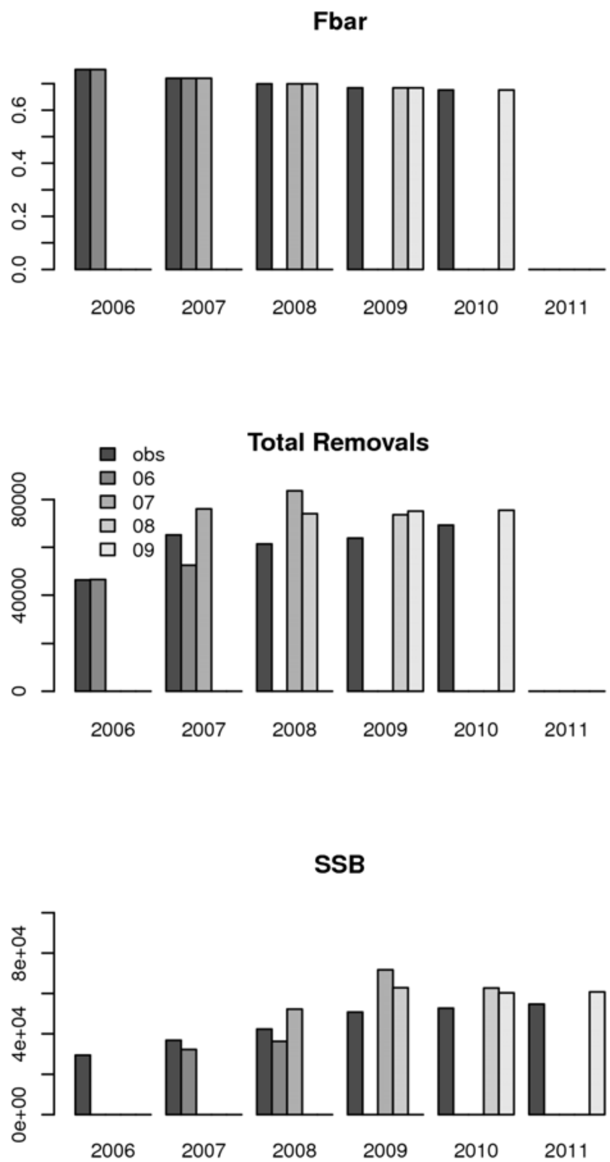



**Figure 11. Estimated total removals and SSB for the years 2006 to 2011, determined from the short term forecasts for 2006 to 2009 but using the fbar values determined from the 2011 assessment. All other forecast settings remain the same as those assumed when the forecast was originally conducted. The 2011 assessment estimates are shown in dark grey. The Estimates from the 2006, 2008 and 2009 forecasts are shown in lighter shades. 2007 estimates are not shown.**

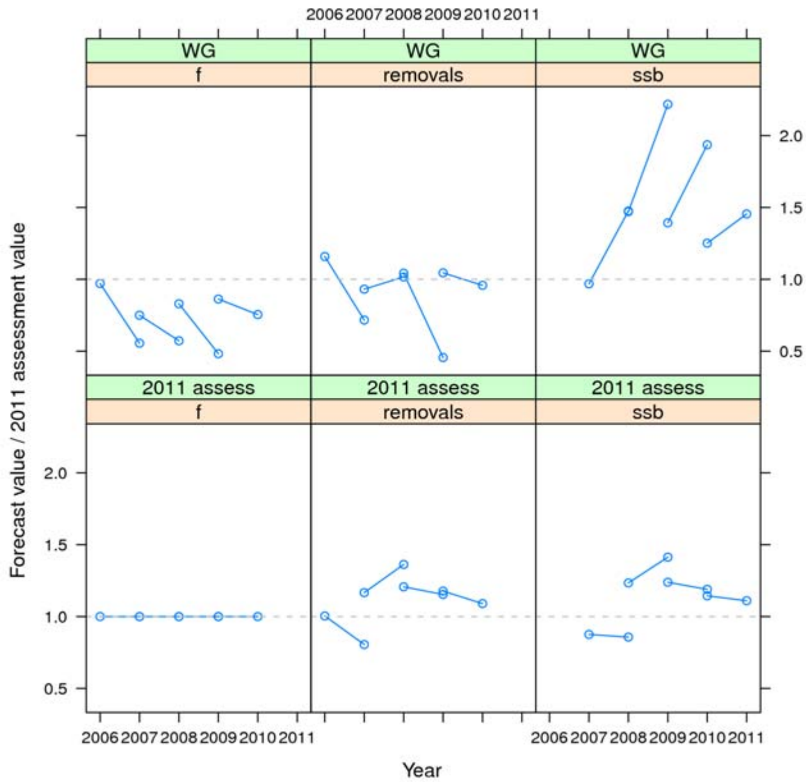
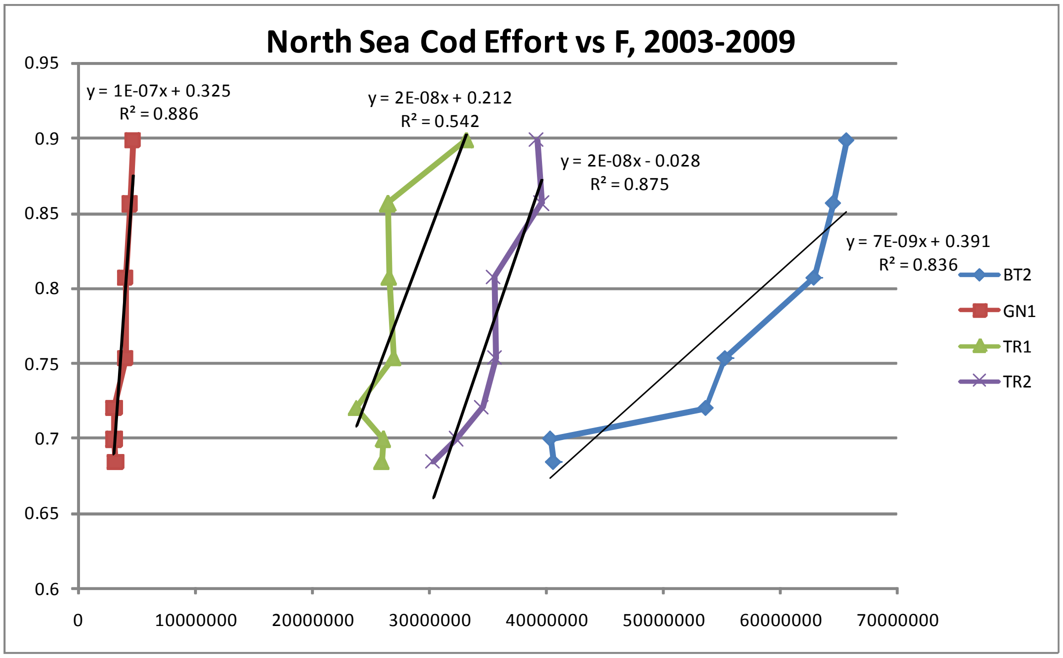



**Figure 12. Estimated total removals and SSB for the years 2006 to 2011, determined from the short term forecasts for 2006 to 2009 as conducted by the WG. Values are shown relative to the 2011 assessment estimates of F, total removals and SSB. Top panel shows estimates as conducted by the WG. Lower panel shows estimates resulting from the same forecasts but using the F values determined by the 2011 assessment.**



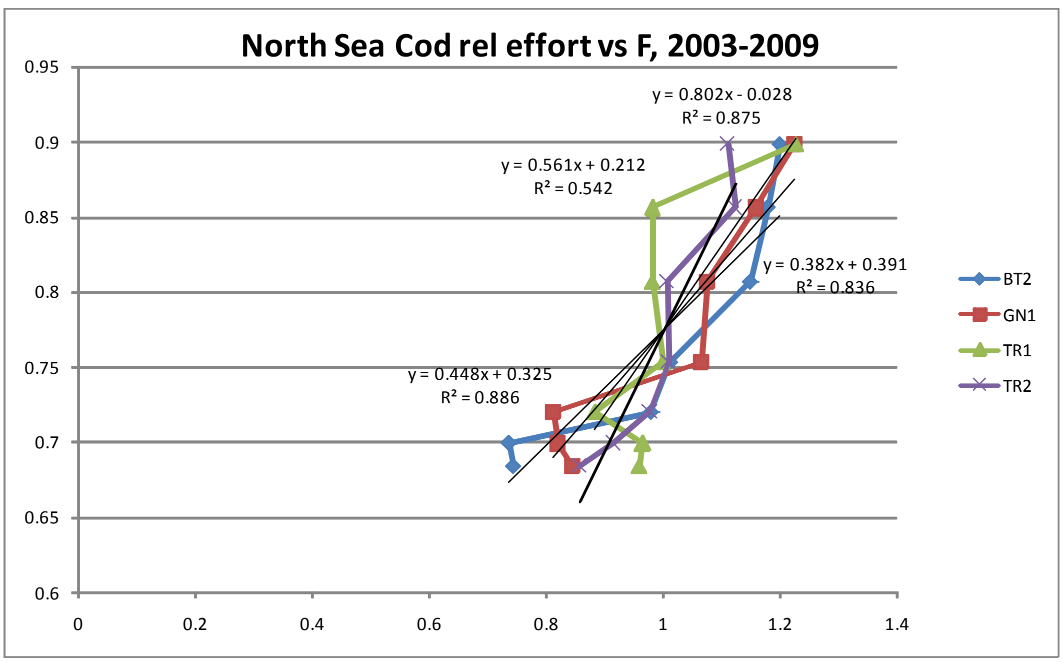




**Figure 13. North Sea cod. Correlation between estimated Fbar (assessment 2011) and EC effort by main gear category, 2003-2009 based on the 2011 assessment. Top – absolute value, bottom, relative value.**

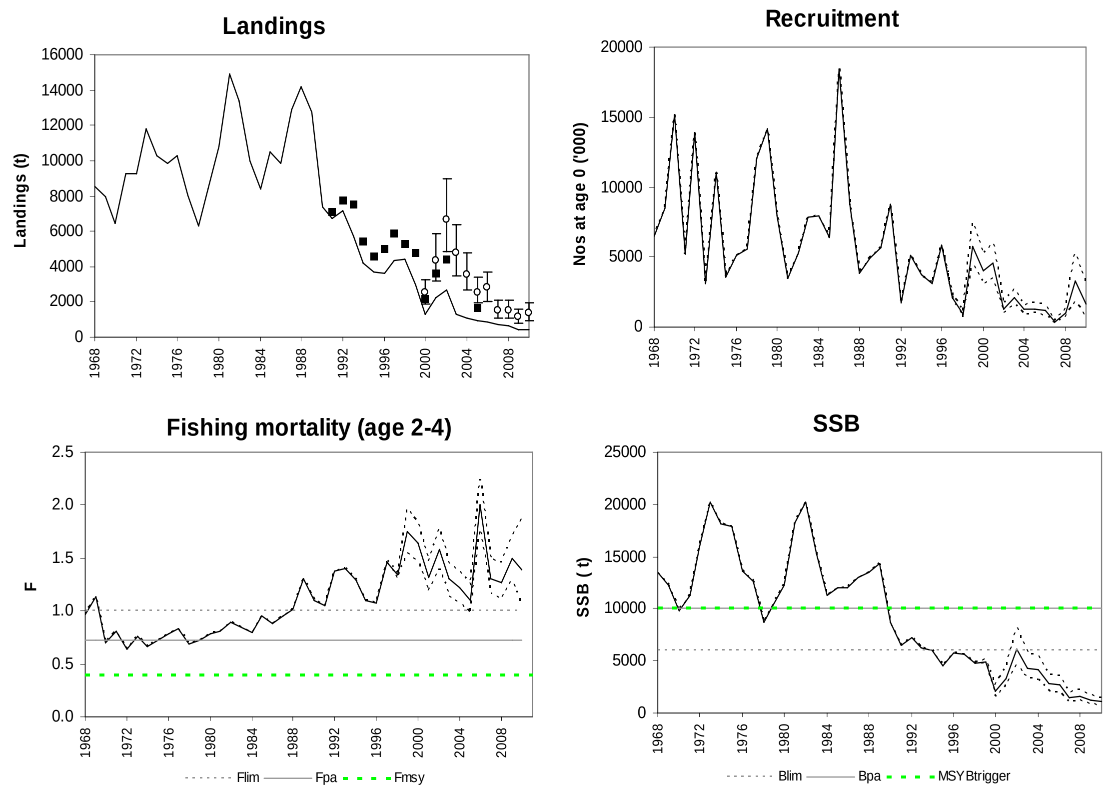



**Figure 14: Cod in Division VIIa (Irish Sea). Summary of stock assessment (weights in '000 tonnes) Landings plot: solid line are reported landings; filled squares are landings incorporating sample-based estimates at three ports; circles are total <u>removals</u> estimates in excess of M=0.2 with 90% confidence intervals from B-Adapt. Recruitment, fishing mortality and SSB: solid lines are median values and dotted lines are 5th and 95th bootstrap percentiles.**

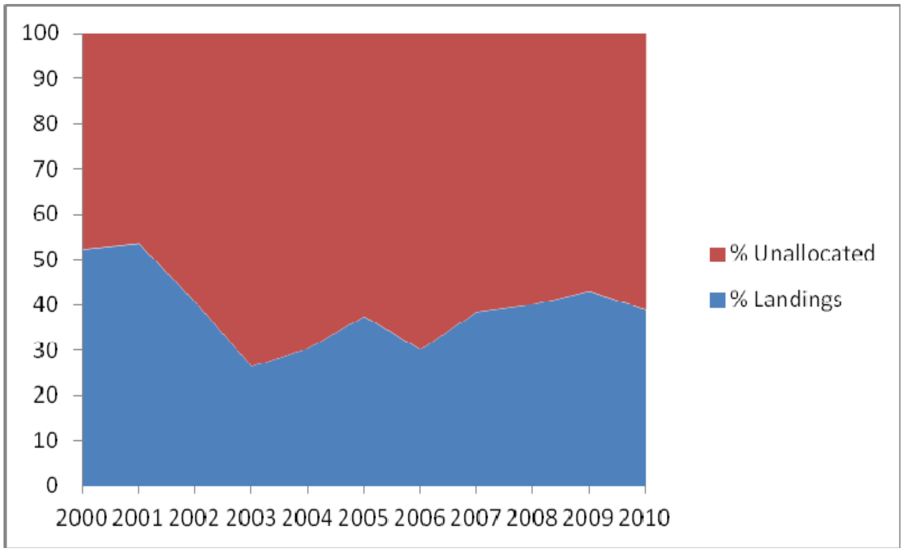



**Figure 15. Proportion of landings and unallocated removals in total removals as estimated for Irish Sea cod in the years 2000 – 2010.**

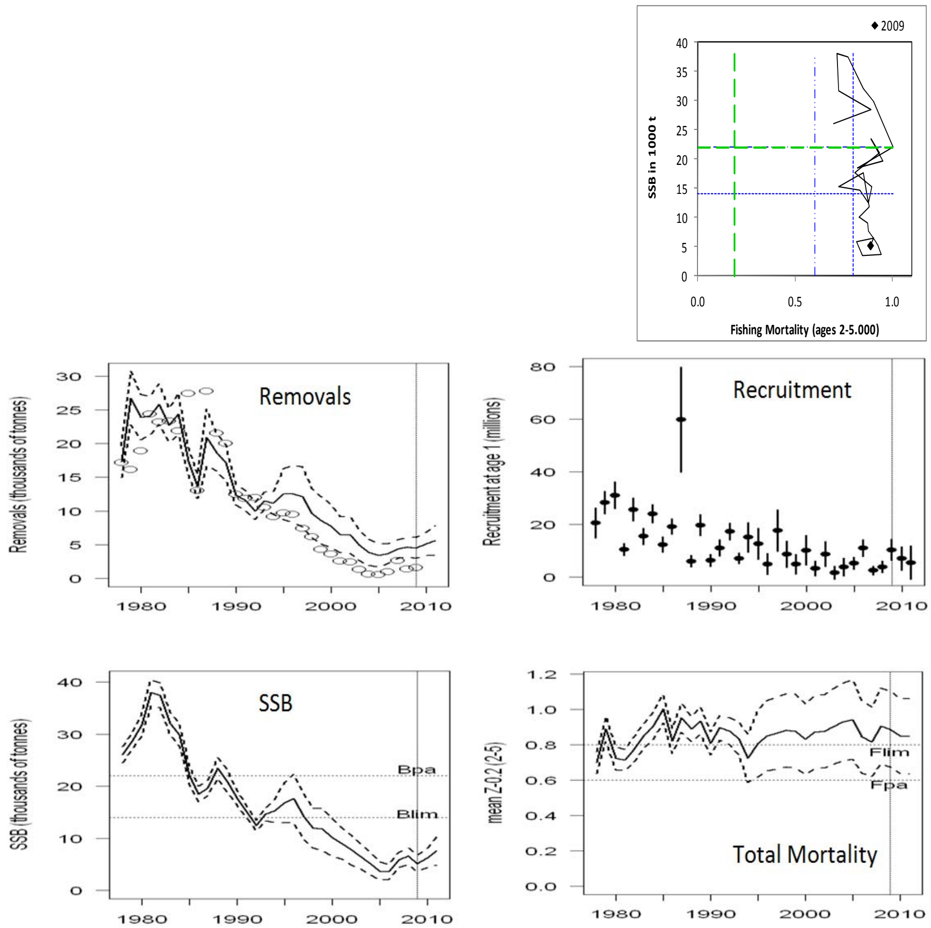



**Figure 16: Cod in Division VIa (West of Scotland). Summary of stock assessment – 2010 assessment - (weights in '000 tonnes). Removals: open circles = observed catches, lines = estimated removals. Estimates are plotted with approximate point-wise 95% confidence bounds. The vertical line in each plot delineates the last year of the historical assessment (2009); estimates to the right of these lines are forecasts.**

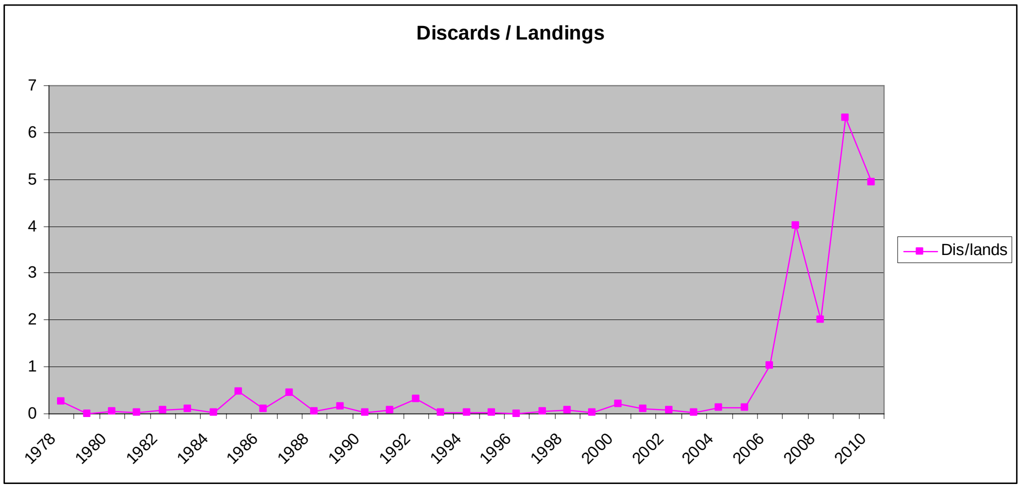



**Figure 17: Cod in Division VIa. Ratio of bulk weight of raised discards to observed landings (data provided to 2011 assessment).**

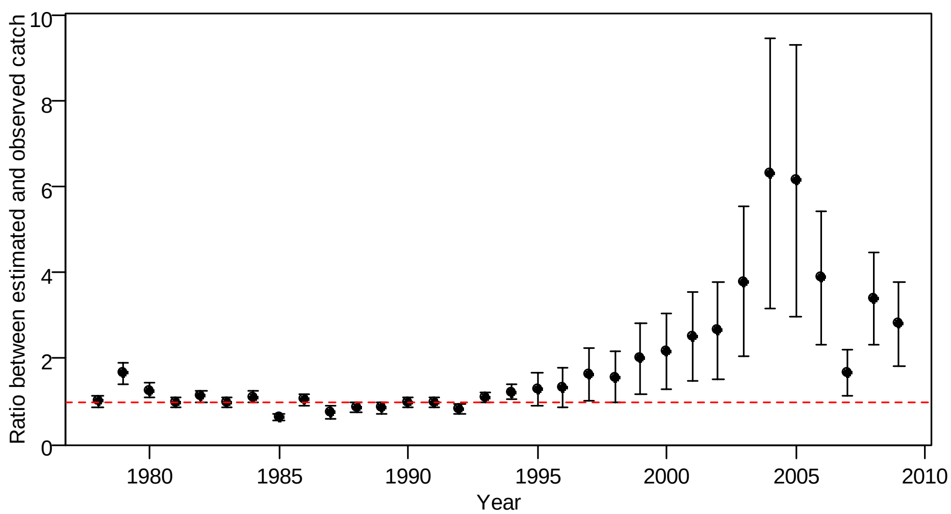



**Figure 18: Cod in Division VIa. Ratio of estimated to observed catch using TSA (2010 assessment). Bars show ± 2 s.e. TSA excludes catch data from 1995 to 2009 inclusive. The 'catch' resulting from TSA is considered removals from both fishing and natural mortality over and above M=0.2.**

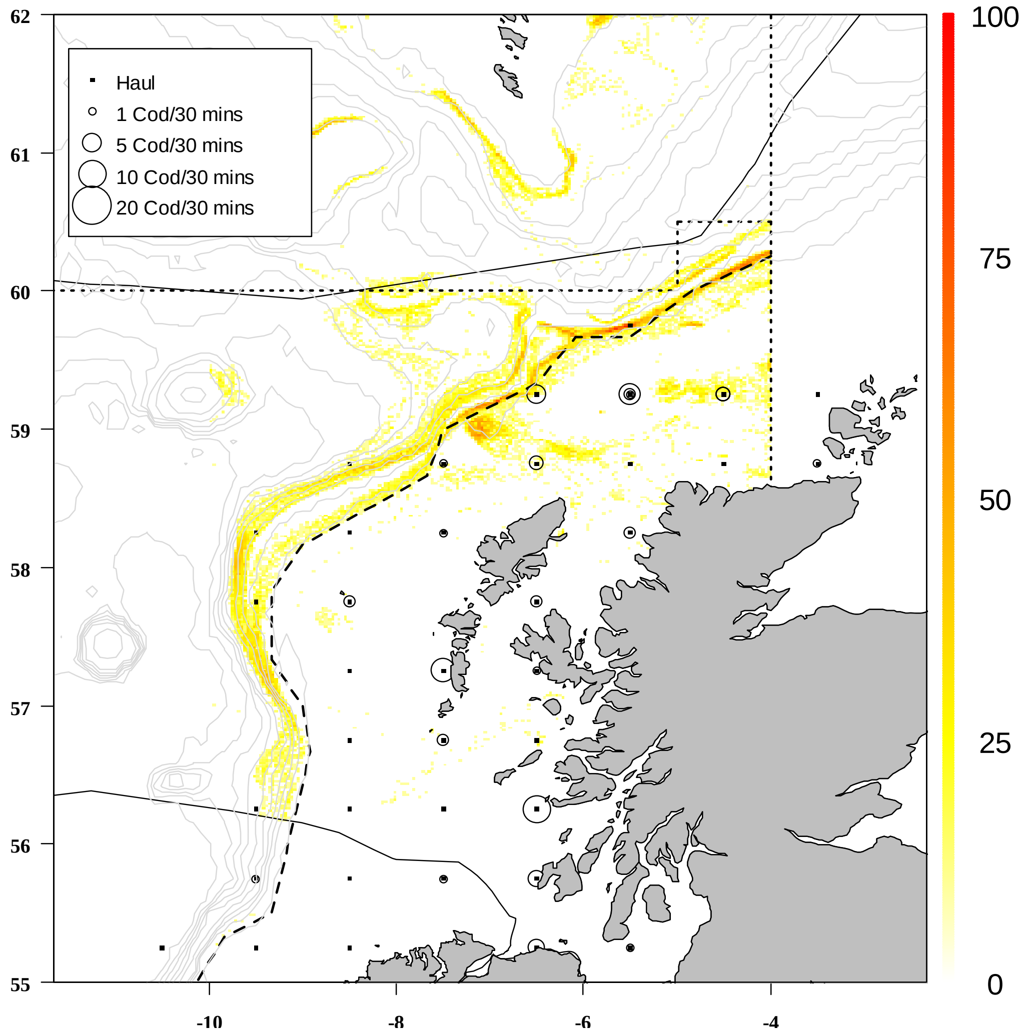



**Figure 19: Scottish Q1 2010 Survey CPUEs of Cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR1 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. Dashed lines show ICES divisions, the broken line represents the cod management line and the solid line shows the limits of the UK EEZ, highlighting the extent of EU waters in subdivision Vb. Depth contours are at 200m intervals.**

# Annex 13 Medium term simulations to answer the question: "Is the plan likely to achieve MSY by 2015?"

J.A.A. De Oliveira, T.J. Earl, M.P. Parker-Humphreys and C.D. Darby

**Summary**

In order to answer the question "Is the plan likely to achieve MSY by 2015?", simulations were carried using the MSE simulation framework previously used for an Impact Assessment of the HCR components (Articles 7 and 8) of Council Regulation (EC) 1342/2008 for West of Scotland and Irish Sea cod, and using a similar framework for North Sea cod. North Sea and West of Scotland cod have a high probability (>95%) of recovery above $\mathbf{B_{lim}}$ by 2015 for both recruitment models ("standard" and "low") for the scenarios that correspond to the way in which these stocks are currently assessed (bias in catch). This drops to 80% for "standard" recruitment and <60% for "low" recruitment for Irish Sea cod, because of the poor state of this stock.

A common feature across all stocks is fishing mortality been driven to levels much lower than previously seen, because the imposition of TAC constraints (± 20%) prevents TAC increases from keeping pace with the rapid recovery that occurs as a result of the relatively low target F (0.4) of the management plans. A consequence is that in all cases for "standard" recruitment and for the way in which the stocks are currently assessed, fishing mortality has a high probability of reducing to Fmsy or below by 2015: 100%, 100% and 90% for North Sea, West of Scotland and Irish Sea cod, respectively. This reduces somewhat for "low" recruitment, but nevertheless remains high: 84%, 99% and 76% for North Sea, West of Scotland and Irish Sea cod, respectively.

When TAC constraints are removed, all stocks have a fishing mortality in 2015 that is closer to the target of 0.4, and higher yields in the case of "standard" recruitment, than when TAC constraints are imposed. This is also the case for "low" recruitment for North Sea and West of Scotland cod, but not for Irish Sea cod, where performance of the management plan in terms of both recovery and yield is poorer when TAC constraints are removed compared to when they are imposed. This implies that for a stock in poor condition, it may be beneficial to impose TAC constraints to prevent a harvest control rule from setting TACs too high based on inaccurate information, thus damaging the resource further.

**Introduction**

"Is the plan likely to achieve MSY by 2015?" This document interprets achieving MSY by 2015 as being at or below Fmsy in 2015. In order to answer this question for Irish Sea and West of Scotland cod, the same MSE (Management Strategy Evaluation) simulation framework that has already been used for the Impact Assessment of the HCR components (Articles 7 and 8) of Council Regulation (EC) 1342/2008, is adopted. A full description of the approach used is given in the AGCREMP report of 2008 (ICES 2009).

The approach for North Sea cod has had to be modified to reflect the change in assessment model from B-Adapt to SAM. The simulation framework described above was developed to work with the former, not the latter. The approach used for North Sea cod is described in Appendix 1. A description of the reference points, scenarios and summary statistics used for the simulations is given in Tables i-iii.

**Table i. The reference points associated with each of the cod stocks.**

| | North Sea | West of Scotland | Irish Sea |
|---|---|---|---|
| $B_{pa}$ | 150000 | 22000 | 10000 |
| $B_{lim}$ | 70000 | 14000 | 6000 |
| $F_{msylo}$ | 0.16 | 0.17 | 0.25 |
| $F_{msy}$ | 0.19 | 0.19 | 0.40 |
| $F_{msyhi}$ | 0.42 | 0.33 | 0.54 |

**Table ii. The scenarios considered are a repeat of those done for AGCREMP (ICES 2009), as follows:**

| MSE components | Scenarios | Description |
|---|---|---|
| Operating Model (OM) | cat | Bias in catch |
| | m | Bias in M |
| Stock Recruit model (SR) | 1 | Fit to full stock-recruit time series ("standard") |
| | 0.5 | As above, but halve the slope at the origin ("low") |
| Observation Error Model (OEM) | cat | Assume bias in catch |
| | m | Assume bias in M |
| | wg | Assume no bias in catch or M |
| TAC constraints (TAC con) | 20% | 20% constraint on year-to-year changes in TAC |
| | - | No constraints on year-to-year changes in TAC |

**Table iii. Description of summary statistics used.**

| Statistic | Description |
|---|---|
| Prob≥$B_{lim}$, Prob≥$B_{pa}$ | Probability that the spawning stock biomass is above or equal to $B_{lim}$ or $B_{pa}$ at the start of 2015 |
| Prob≤$F_{msylo}$, Prob≤$F_{msy}$, Prob≤$F_{msyhi}$ | Probability that Fbar (catch) is below or equal to $F_{msylo}$, $F_{msy}$ or $F_{msyhi}$ during 2015 |
| SSB | Spawning stock biomass at the start of 2015 |
| L, D, C | Landings, discards and catch during 2015 |
| FL, FD, FC | Fbar for landings, discards and catch during 2015 |

## North Sea cod

The operating model for North Sea cod is conditioned on the 2011 SAM assessment for North Sea cod, as applied by WGNSSK during May 2011 (Figure 1a). The harvest control rules associated with the management plan are based on Article 8 of Council Regulation (EC) 1342/2008 (Appendix 2 and 3). Two scenarios for recruitment were considered, based on the Beverton-Holt stock-recruit relationship estimated in the 2011 SAM assessment, and these are shown in Figure 1b. Results for the simulations are given in Table 1.

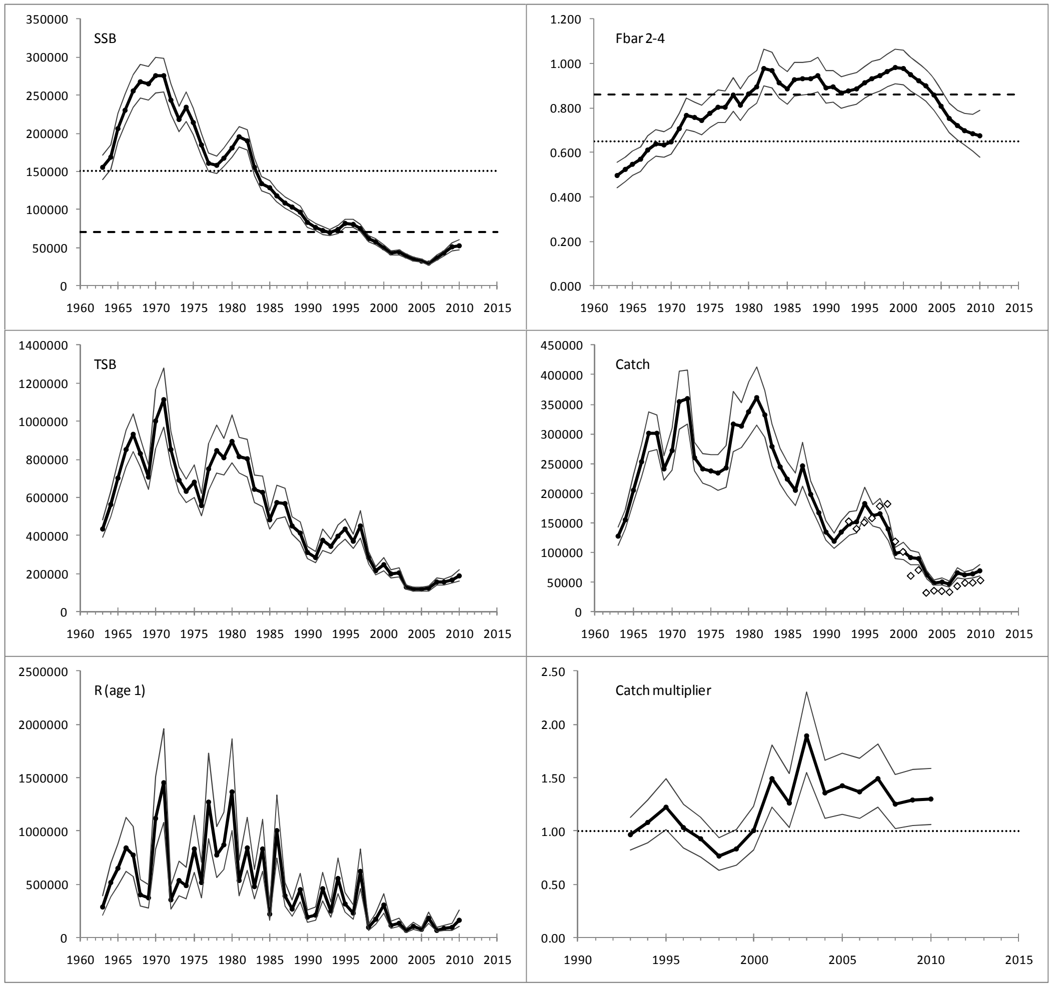



**Figure 1a. North Sea cod. Clockwise from top left, point-wise estimates and 95% confidence intervals of spawning stock biomass (SSB), total stock biomass (TSB), recruitment (R(age 1)), the catch multiplier, catch and Fbar (catch, ages 2-4), from the SAM base run. The heavy lines represent the point-wise estimate, and the light lines point-wise 95% confidence intervals. The open diamonds given in the catch plot represent model estimates of the total catch excluding unallocated mortality, while the solid lines represent the total catch including unallocated mortality from 1993 onwards. The horizontal broken lines in the SSB plot indicate $B_{lim}$=70 000t and $B_{pa}$=150 000t, and those in the Fbar plot $F_{pa}$=0.65 and $F_{lim}$=0.86. The horizontal broken line in the catch multiplier plot indicates a multiplier of 1. Catch, SSB and TSB are in tons, and R in thousands.**

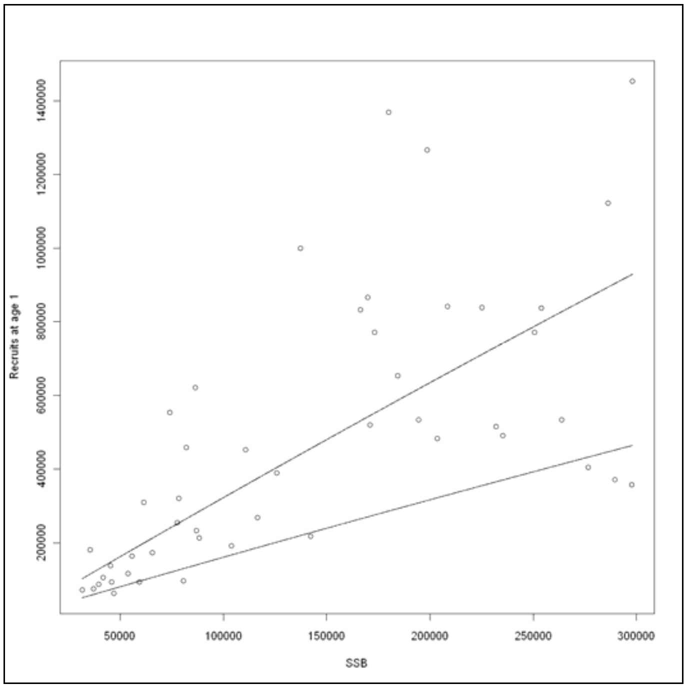



**Figure 1b. North Sea cod. Stock-recruit relationship, with circles representing the stock-recruit estimates from the 2011 SAM assessment, and the top curve representing the fit of a Beverton-Holt stock-recruit curve to these estimates from the 2011 SAM assessment. The bottom curve is the same as the top curve, but with the slope at the origin halved.**

**Table 1. North Sea cod. Summary results for 14 scenarios for the year 2015. The columns labelled "OM", "SR", "OEM", and "TAC con" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii. Values for the reference points used are given in Table i, and the summary statistics are described in Table iii. Values for SSB, L, D and C are in thousand tons.**

| | OM | SR | OEM | TAC con | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **cat** | **20%** | **1.00** | **1.00** | **0.99** | **1.00** | **1.00** | **370** | **53.3** | **14.8** | **68.2** | **0.06** | **0.02** | **0.08** |
| 2 | cat | 1 | m | 20% | 1.00 | 1.00 | 0.98 | 1.00 | 1.00 | 357 | 56.8 | 15.7 | 72.9 | 0.06 | 0.02 | 0.09 |
| 3 | cat | 1 | wg | 20% | 1.00 | 1.00 | 0.82 | 0.94 | 1.00 | 330 | 70.9 | 20.6 | 92.0 | 0.09 | 0.03 | 0.12 |
| 4 | m | 1 | cat | 20% | 1.00 | 0.99 | 0.99 | 1.00 | 1.00 | 264 | 39.8 | 12.0 | 52.0 | 0.06 | 0.02 | 0.08 |
| 5 | m | 1 | m | 20% | 1.00 | 0.99 | 0.98 | 1.00 | 1.00 | 256 | 42.2 | 12.7 | 55.2 | 0.07 | 0.02 | 0.09 |
| 6 | m | 1 | wg | 20% | 1.00 | 0.95 | 0.80 | 0.93 | 1.00 | 239 | 53.0 | 16.6 | 69.8 | 0.09 | 0.03 | 0.12 |
| **7** | **cat** | **0.5** | **cat** | **20%** | **1.00** | **0.98** | **0.65** | **0.84** | **1.00** | **241** | **52.2** | **11.6** | **64.1** | **0.11** | **0.04** | **0.14** |
| 8 | cat | 0.5 | m | 20% | 1.00 | 0.96 | 0.53 | 0.75 | 1.00 | 227 | 54.1 | 12.1 | 66.4 | 0.12 | 0.04 | 0.16 |
| 9 | cat | 0.5 | wg | 20% | 1.00 | 0.83 | 0.10 | 0.25 | 0.98 | 197 | 67.7 | 16.4 | 84.7 | 0.17 | 0.06 | 0.23 |
| 10 | m | 0.5 | cat | 20% | 1.00 | 0.69 | 0.56 | 0.79 | 1.00 | 170 | 38.7 | 9.5 | 48.3 | 0.11 | 0.04 | 0.15 |
| 11 | m | 0.5 | m | 20% | 1.00 | 0.64 | 0.48 | 0.73 | 1.00 | 162 | 39.1 | 9.8 | 49.5 | 0.12 | 0.04 | 0.16 |
| 12 | m | 0.5 | wg | 20% | 1.00 | 0.44 | 0.08 | 0.22 | 0.98 | 143 | 49.5 | 13.1 | 63.4 | 0.17 | 0.06 | 0.23 |
| 13 | cat | 1 | cat | - | 1.00 | 1.00 | 0.08 | 0.17 | 1.00 | 324 | 131.5 | 40.1 | 173.8 | 0.18 | 0.06 | 0.24 |
| 14 | cat | 0.5 | cat | - | 1.00 | 0.97 | 0.02 | 0.05 | 0.98 | 219 | 86.1 | 20.4 | 107.8 | 0.21 | 0.07 | 0.28 |

- For the scenarios that correspond to the way the North Sea cod stock is currently assessed (scenarios 1 and 7 in bold in Table 1), recovery of SSB to above $\mathbf{B_{lim}}$ by 2015 is achieved with more than 95% probability for both the "standard" and "low" recruitment models.
- Similarly, for the scenarios that correspond to the way the North Sea cod stock is currently assessed, the reduction of Fbar (catch) to Fmsy or below by 2015 is achieved with a more than 95% probability for the "standard" recruitment model; however it is achieved with less 84% probability for the "low" recruitment model.
- The imposition of TAC constraints of ± 20% leads to values of F by 2015 that are much lower than ever seen before. This occurs because TAC constraints prevent TAC increases from keeping pace with the rapid recovery that occurs as a result of the relatively low target F (0.4) of the management plan.
- When TAC constraints are removed (scenarios 13 and 14), probability of recovery remains high, larger yields are obtained, and F values are closer to 0.4 than when TAC constraints are kept. However, the target F is not reached by 2015 because the short-term forecast recruitment assumption (average of last 10 years of recruitment) causes a bias when there is a rapid recovery in recruitment.
- As expected, probability of recovery by 2015 and yield is lower for the "low" recruitment model than for the "standard" recruitment model.

**West of Scotland cod**

The operating model for West of Scotland cod is conditioned on the 2011 TSA assessment for West of Scotland cod, as applied by WGCSE during May 2011. Since the AGCREMP MSE framework was not designed to accommodate TSA, B-Adapt was used to re-fit the data (the same procedure was used for the Impact Assessment performed in early 2009). Figure 2a compares fishing mortality estimates using the two approaches. The assessment estimates for B-Adapt are given in Figure 2b. The harvest control rules associated with the management plan are based on Article 7 of Council Regulation (EC) 1342/2008 (Appendix 2 and 3). Two scenarios for recruitment were considered, based on a Ricker stock-recruit relationship fitted to the assessment estimates, and these are shown in Figure 2c. Results for the simulations are given in Table 2.

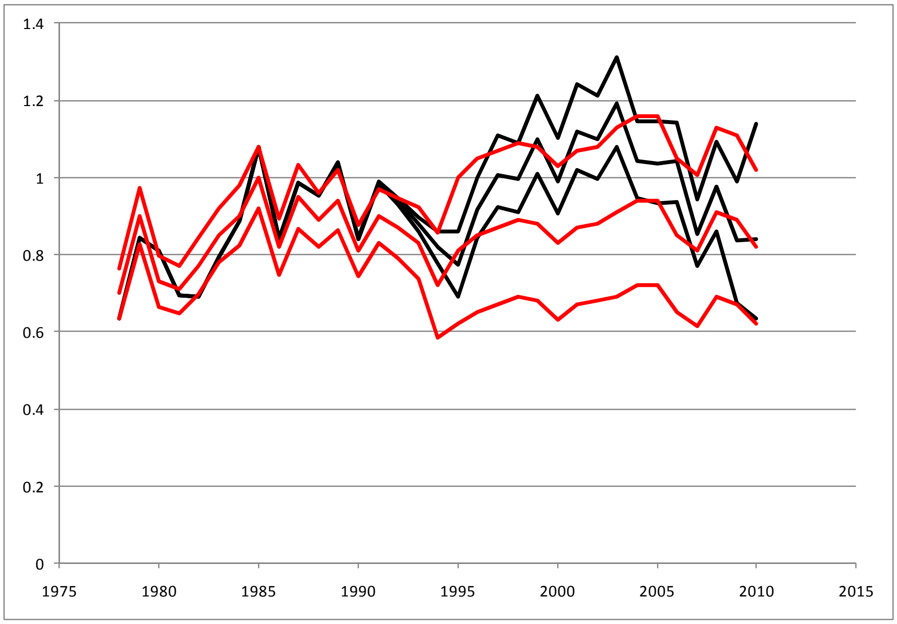



**Figure 2a. West of Scotland cod. A comparison of Fbar (catch, ages 2-5) from TSA (red line) and B-Adapt. The middle line in each case reflects the point estimate/median, while the upper and lower lines represent confidence bounds.**

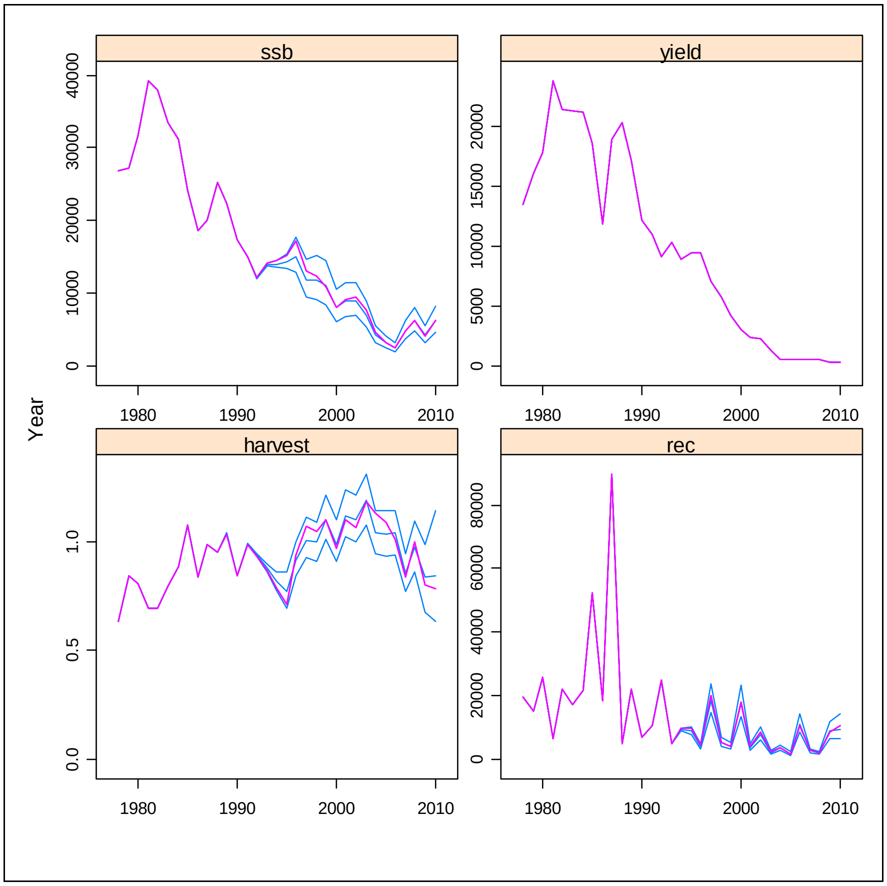



**Figure 2b. West of Scotland cod. Estimates from the B-Adapt model fit with point estimates in pink and median, upper and lower confidence bounds in blue. Clockwise from top-left, SSB, yield (reported landings), recruitment (age 1) and harvest (Fbar catch, ages 2-5).**

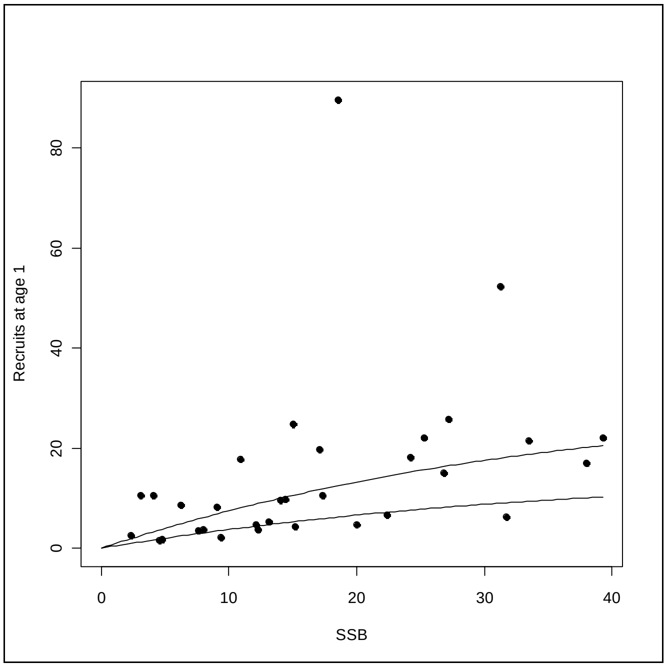



**Figure 2c. West of Scotland cod. Stock-recruit relationship, with dots representing the stock-recruit estimates from the B-Adapt assessment, and the top curve representing the fit of a Ricker stock-recruit curve to these estimates. The bottom curve is the same as the top curve, but with the slope at the origin halved.**

**Table 2. West of Scotland cod. Summary results for 14 scenarios for the year 2015. The columns labelled "OM", "SR", "OEM", and "TAC con" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii. Values for the reference points used are given in Table i, and the summary statistics are described in Table iii. Values for SSB, L, D and C are in thousand tons.**

| | OM | SR | OEM | TAC con | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **cat** | **20%** | **1.00** | **0.99** | **1.00** | **1.00** | **1.00** | **54.4** | **0.844** | **0.777** | **1.581** | **0.01** | **0.02** | **0.03** |
| 2 | cat | 1 | m | 20% | 1.00 | 0.99 | 1.00 | 1.00 | 1.00 | 54.5 | 0.618 | 0.627 | 1.263 | 0.01 | 0.02 | 0.02 |
| 3 | cat | 1 | wg | 20% | 1.00 | 0.99 | 1.00 | 1.00 | 1.00 | 54.5 | 0.774 | 0.714 | 1.486 | 0.01 | 0.02 | 0.03 |
| 4 | m | 1 | cat | 20% | 0.72 | 0.39 | 0.95 | 0.97 | 1.00 | 19.9 | 0.377 | 0.545 | 0.902 | 0.02 | 0.04 | 0.06 |
| 5 | m | 1 | m | 20% | 0.72 | 0.40 | 1.00 | 1.00 | 1.00 | 20.0 | 0.252 | 0.360 | 0.610 | 0.01 | 0.03 | 0.04 |
| 6 | m | 1 | wg | 20% | 0.72 | 0.40 | 0.98 | 0.99 | 1.00 | 19.9 | 0.330 | 0.481 | 0.796 | 0.02 | 0.03 | 0.05 |
| **7** | **cat** | **0.5** | **cat** | **20%** | **0.99** | **0.89** | **0.98** | **0.99** | **1.00** | **32.6** | **0.788** | **0.533** | **1.307** | **0.01** | **0.03** | **0.04** |
| 8 | cat | 0.5 | m | 20% | 0.99 | 0.92 | 1.00 | 1.00 | 1.00 | 33.0 | 0.442 | 0.313 | 0.742 | 0.01 | 0.02 | 0.03 |
| 9 | cat | 0.5 | wg | 20% | 0.99 | 0.90 | 0.99 | 0.99 | 1.00 | 32.9 | 0.655 | 0.460 | 1.105 | 0.01 | 0.03 | 0.04 |
| 10 | m | 0.5 | cat | 20% | 0.32 | 0.10 | 0.86 | 0.90 | 0.98 | 10.5 | 0.377 | 0.364 | 0.712 | 0.03 | 0.06 | 0.09 |
| 11 | m | 0.5 | m | 20% | 0.33 | 0.10 | 1.00 | 1.00 | 1.00 | 10.8 | 0.143 | 0.181 | 0.329 | 0.01 | 0.03 | 0.04 |
| 12 | m | 0.5 | wg | 20% | 0.33 | 0.10 | 0.94 | 0.97 | 1.00 | 10.5 | 0.252 | 0.287 | 0.555 | 0.02 | 0.05 | 0.07 |
| 13 | cat | 1 | cat | - | 0.84 | 0.59 | 0.13 | 0.16 | 0.32 | 25.8 | 3.765 | 5.961 | 10.173 | 0.15 | 0.35 | 0.50 |
| 14 | cat | 0.5 | cat | - | 0.52 | 0.28 | 0.22 | 0.25 | 0.39 | 14.9 | 1.913 | 2.493 | 4.466 | 0.13 | 0.30 | 0.43 |

- For the scenarios that correspond to the way the West of Scotland cod stock is currently assessed (scenarios 1 and 7 in bold in Table 2), recovery of SSB to above $\mathbf{B_{lim}}$ by 2015 is achieved with more than 95% probability for both the "standard" and "low" recruitment models. Probabilities are somewhat lower when OM bias is due to changes in natural mortality rather than to unreported catch.
- Strict application of the HCR reduces fishing mortality (landings and discards) to very low levels (<0.1) in 2015. Such low levels of fishing mortality have not been recorded previously and would almost certainly imply a bycatch only fishery during the rebuilding of the stock. As a result, the reduction in Fbar (catch) to Fmsy or below by 2015 is achieved with more than 90% probability for all cases where the TAC constraint is applied, regardless of the recruitment model used.
- The low level of fishing mortality results from the constraint on the change in TAC. As the stock recovers following the reduction in mortality to very low levels the increase in the stock biomass is considerably greater than that of the TAC and therefore the proportional removals remain very low.
- If the change in TAC is not constrained, total fishing mortality is closer to the target level of 0.4 and yields is somewhat higher. As a result of the higher levels of fishing mortality, the probability that the stock will rebuild to above $B_{lim}$ by 2015 is reduced to 84% for the "standard" recruitment scenario, with an associated low probability of Fbar (catch) being below $F_{msy}$ (25%).
-

**Irish Sea cod**

The operating model for Irish Sea cod is conditioned on the 2011 B-Adapt assessment for Irish Sea cod, as applied by WGCSE during May 2011 (Figure 3a). The harvest control rules associated with the management plan are based on Article 7 of Council Regulation (EC) 1342/2008 (Appendix 2 and 3). Two scenarios for recruitment were considered, based on a Ricker stock-recruit relationship fitted to the assessment estimates, and these are shown in Figure 3b. Results for the simulations are given in Table 3.

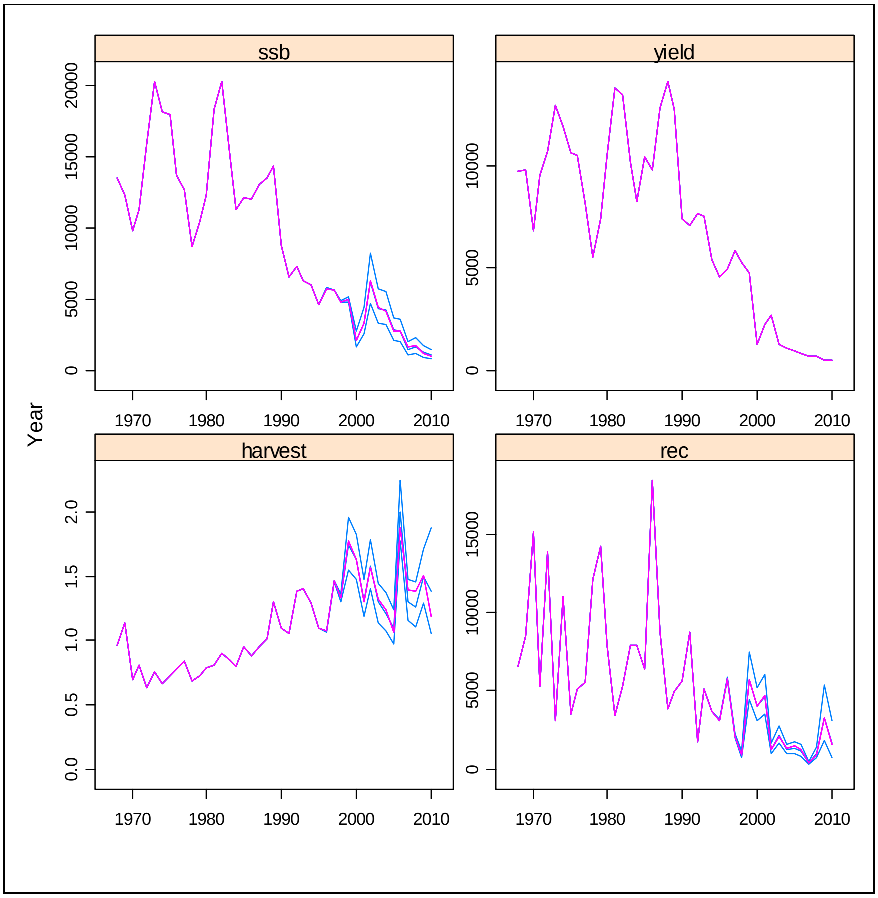



**Figure 3a. Irish Sea cod. Estimates from the B-Adapt model fit with point estimates in pink and median, upper and lower confidence bounds in blue. Clockwise from top-left, SSB, yield (reported landings), recruitment (age 1) and harvest (Fbar catch, ages 2-4).**

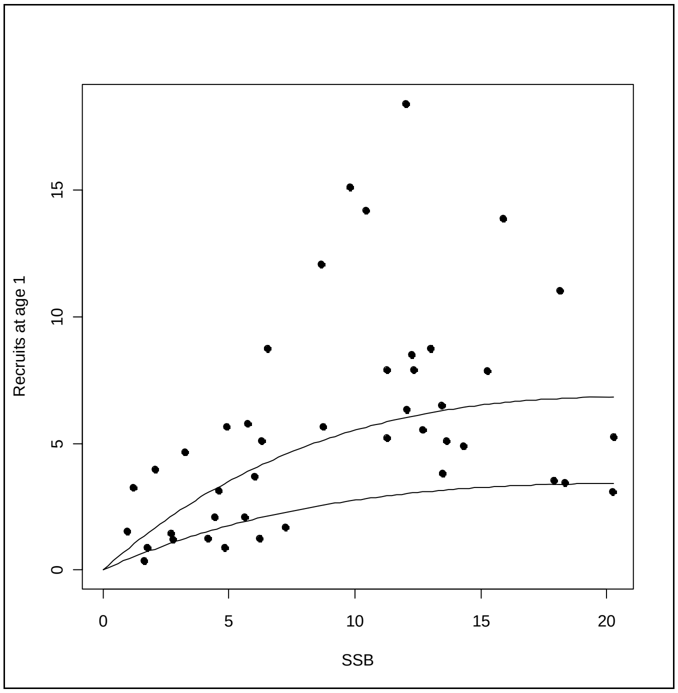



**Figure 3b. Irish Sea cod. Stock-recruit relationship, with dots representing the stock-recruit estimates from the B-Adapt assessment, and the top curve representing the fit of a Ricker stock-recruit curve to these estimates. The bottom curve is the same as the top curve, but with the slope at the origin halved.**

**Table 3. Irish Sea cod. Summary results for 14 scenarios <u>for the year 2015</u>. The columns labelled "OM", "SR", "OEM", and "TAC con" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii. Values for the reference points used are given in Table i, and the summary statistics are described in Table iii. Values for SSB, L, D and C are in thousand tons.**

| | OM | SR | OEM | TAC con | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **cat** | **20%** | **0.80** | **0.54** | **0.68** | **0.90** | **0.94** | **10.7** | **2.188** | **0.000** | **2.188** | **0.18** | **0.00** | **0.18** |
| 2 | cat | 1 | m | 20% | 0.90 | 0.62 | 0.95 | 0.98 | 0.99 | 11.9 | 1.300 | 0.000 | 1.300 | 0.10 | 0.00 | 0.10 |
| 3 | cat | 1 | wg | 20% | 0.80 | 0.56 | 0.71 | 0.90 | 0.94 | 11.0 | 2.097 | 0.000 | 2.097 | 0.17 | 0.00 | 0.17 |
| 4 | m | 1 | cat | 20% | 0.26 | 0.08 | 0.48 | 0.80 | 0.90 | 3.4 | 0.758 | 0.000 | 0.758 | 0.25 | 0.00 | 0.25 |
| 5 | m | 1 | m | 20% | 0.28 | 0.08 | 0.86 | 0.98 | 0.99 | 3.6 | 0.457 | 0.000 | 0.457 | 0.14 | 0.00 | 0.14 |
| 6 | m | 1 | wg | 20% | 0.26 | 0.08 | 0.54 | 0.81 | 0.90 | 3.4 | 0.699 | 0.000 | 0.699 | 0.23 | 0.00 | 0.23 |
| **7** | **cat** | **0.5** | **cat** | **20%** | **0.57** | **0.24** | **0.52** | **0.76** | **0.84** | **6.6** | **1.685** | **0.000** | **1.685** | **0.25** | **0.00** | **0.25** |
| 8 | cat | 0.5 | m | 20% | 0.65 | 0.31 | 0.87 | 0.94 | 0.97 | 7.5 | 0.992 | 0.000 | 0.992 | 0.12 | 0.00 | 0.12 |
| 9 | cat | 0.5 | wg | 20% | 0.58 | 0.24 | 0.49 | 0.71 | 0.80 | 6.6 | 1.652 | 0.000 | 1.652 | 0.25 | 0.00 | 0.25 |
| 10 | m | 0.5 | cat | 20% | 0.04 | 0.00 | 0.18 | 0.47 | 0.66 | 1.6 | 0.519 | 0.000 | 0.519 | 0.41 | 0.00 | 0.41 |
| 11 | m | 0.5 | m | 20% | 0.04 | 0.00 | 0.53 | 0.76 | 0.89 | 1.8 | 0.330 | 0.000 | 0.330 | 0.24 | 0.00 | 0.24 |
| 12 | m | 0.5 | wg | 20% | 0.04 | 0.00 | 0.23 | 0.48 | 0.63 | 1.6 | 0.480 | 0.000 | 0.480 | 0.41 | 0.00 | 0.41 |
| 13 | cat | 1 | cat | - | 0.54 | 0.25 | 0.20 | 0.42 | 0.60 | 6.2 | 2.607 | 0.000 | 2.607 | 0.45 | 0.00 | 0.45 |
| 14 | cat | 0.5 | cat | - | 0.25 | 0.07 | 0.25 | 0.49 | 0.64 | 3.8 | 1.238 | 0.000 | 1.238 | 0.40 | 0.00 | 0.40 |

- For the scenarios that correspond to the way the Irish Sea cod stock is currently assessed (scenarios 1 and 7 in bold in Table 3), recovery of SSB to above $\mathbf{B_{lim}}$ by 2015 is achieved with 80% probability for the "standard" recruitment models, but with less than 60% probability for the "low" recruitment model. Nevertheless, these outcome are substantially more optimistic to when the Impact Assessment for Irish Sea cod was carried out in early 2009 because of the improved stock status at the start of the simulation period due to improved recruitment in 2009 (Figure 3a).
- Similarly, for the scenarios that correspond to the way the Irish Sea cod stock is currently assessed, the reduction of Fbar (catch) to Fmsy or below by 2015 is achieved with 90% probability for the "standard" recruitment model, but with less than 80% for the low recruitment model.
- The imposition of TAC constraints of ± 20% leads to values of F by 2015 that are much lower than ever seen before, particularly for the "standard" recruitment model. This occurs because TAC constraints prevent TAC increases from keeping pace with the rapid recovery that occurs as a result of the relatively low target F (0.4) of the management plan.
- When TAC constraints are removed, there is ~20% increase in median catches but this is associated with a ~40% reduction in SSB and substantial reduction in the probability of recovery to above $B_{lim}$ by 2015 (from 80% to 54%) for the "standard" recruitment model. In the case of the "low" recruitment model, removing the TAC constraint leads to poorer performance across the board, with a ~25% reduction in median catch, a ~40% reduction in SSB and a substantial reduction in the probability of recovery to above $B_{lim}$ by 2015 (from 57% to 25%), even though the target F of 0.4 is achieved by 2015. This implies that for a stock in poor condition, it may be beneficial to impose TAC constraints to prevent a harvest control rule from setting TACs too high based on inaccurate information, thus damaging the resource further.
- As expected, probability of recovery by 2015 and yield is lower for the "low" recruitment model than for the "standard" recruitment model.

## References

ICES. 2009. Report of the Ad hoc Group on Cod Recovery Management Plan (AGCREMP), 18–19 August 2008, Copenhagen, Denmark. ICES CM 2008/ACOM:61. 83 pp.

ICES. 2011. Report of the Workshop on the Analysis of the Benchmark of Cod in Su-barea IV (North Sea), Division VIId (Eastern Channel) and Division IIIa (Skagerrak) (WKCOD 2011), 7–9 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:51. 94 pp.

## Approach used for North Sea cod

The framework used for the MSE for North Sea cod was developed from the stochastic projection software used to provide catch options advice for North Sea cod (see Annex 2 in ICES 2011). This is because the MSE framework used for earlier Impact Assessments for North Sea cod were designed for B-Adapt, and not for the SAM model now used for North Sea cod, which is structurally different to B-Adapt.

The main differences between the two frameworks are described in the following table.

| | B-Adapt MSE framework | SAM MSE framework |
|---|---|---|
| Platform | FLR | R |
| Operating Model | Conditioned on B-Adapt assessment | Conditioned on SAM assessment |
| Recruitment | Fits Ricker curve to point estimate of stock-recruit pairs | Takes point estimates of Beverton-Holt parameters |
| Simulations | Based on 250 bootstrap iterations representing 250 simulated populations | Applies variance-covariance matrix to obtain 100 simulated populations |
| Assessment | Uses XSA coupled with bias assumption to simulate B-Adapt assessment, resulting in 250 assessments for each year | In the first year, applies variance-covariance matrix to the most recent two years' Fs and Ns, the recruitment time series and Fs in 2008 for each of the 100 simulated populations to obtain 10 SAM "assessments" for each simulated population, resulting in 1000 "assessments". For all subsequent years, the variance-covariance matrix is applied to obtain the most recent Fs, Ns and recruitment, which is added to the ones generated in the previous years. |

The SAM MSE framework is likely to underestimate assessment uncertainty slightly because although the WG assessment assumes that there is random variability around the exponential equation, which would account for demographic variability and features such as migration or departures from the assumed natural mortality values (CV=~0.1), the SAM MSE framework ignores this feature.

## Appendix 2

Interpretation of Articles 7 and 8 of Council Regulation (EC) 1342/2008
as used for simulations

<u>Article 7</u>

SSB < $B_{lim}$

F = 0.75 × F in previous year

$B_{lim}$ ≤ SSB < $B_{pa}$

F = 0.85 × F in previous year

or

F = 0.4

whichever is greater

SSB ≥ $B_{pa}$

F = 0.9 × F in previous year

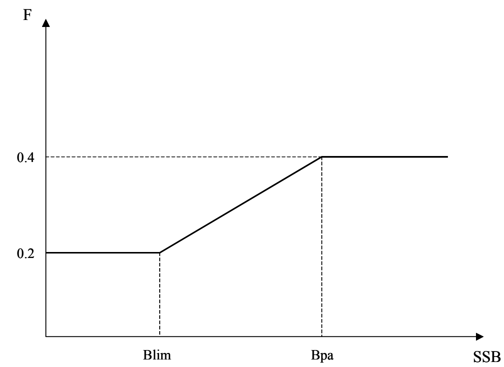
or

F = 0.4

whichever is greater

Apply ±20% TAC constraint in all cases

Article 8

| Transition Phase | *Long-term Phase* |
|---|---|
| $F_{2009} = 0.75 \times F_{2008}$<br><br>$F_{2010} = 0.65 \times F_{2008}$<br><br>$F_{2011} = 0.55 \times F_{2008}$<br>…<br>etc<br><br>Calculate $TAC_1$ | <br><br>Calculate $TAC_2$ |

For both phases, apply ±20% TAC constraint in all cases from 2010 onwards

Use TAC1 until TAC1 < TAC2 for the first time, then use TAC2 from then onwards

## Appendix 3

Articles 5-9 from Council Regulation (EC) No 1342/2008

*Article 5*

**Objective of the plan**

1 ) The plan referred to in Article 1 shall ensure the sustainable exploitation of the cod stocks on the basis of maximum sustainable yield.
2 ) The objective set out in paragraph 1 shall be attained while maintaining the following fishing mortality on cod on appropriate age groups:

| Stock | Fishing mortality |
|---|---|
| Cod in the Kattegat | 0,4 |
| Cod to the west of Scotland | 0,4 |
| Cod in the Irish Sea | 0,4 |

1. For the cod stock in the North Sea, the Skagerrak and the eastern Channel, the objective set out in paragraph 1 shall be attained while maintaining the fishing mortality on cod on appropriate age groups referred to in Article 8.

*Article 6*

**Minimum and precautionary levels**

The minimum spawning biomass level and the precautionary spawning biomass level for each of the cod stocks shall be as follows:

| Stock | Minimum spawning biomass Levels in tonnes | Precautionary spawning biomass Levels in tonnes |
|---|---|---|
| Cod in the Kattegat | 6 400 | 10 500 |
| Cod in the North Sea, Skagerrak and eastern Channel | 70 000 | 150 000 |
| Cod to the west of Scotland | 14 000 | 22 000 |
| Cod in the Irish Sea | 6 000 | 10 000 |

### *Article 7*

Procedure for setting TACs for cod stocks in the Kattegat the west of Scotland and the Irish Sea

1. Each year, the Council shall decide on the TAC for the following year for each of the cod stocks in the Kattegat, the west of Scotland and the Irish Sea. The TAC shall be calculated by deducting the following quantities from the total removals of cod that are forecast by STECF as corresponding to the fishing mortality rates referred to in paragraphs 2 and 3:

   (a) a quantity of fish equivalent to the expected discards of cod from the stock concerned;

   (b) as appropriate a quantity corresponding to other sources of cod mortality caused by fishing to be fixed on the basis of a proposal from the Commission.

2. The TAC shall, based on the advice of STECF, satisfy all of the following conditions:

   (a) if the size of the stock on 1 January of the year of application of the TAC is predicted by STECF to be below the minimum spawning biomass level established in Article 6, the fishing mortality rate shall be reduced by 25 % in the year of application of the TAC as compared with the fishing mortality rate in the previous year;

   (b) if the size of the stock on 1 January of the year of application of the TAC is predicted by STECF to be below the precautionary spawning biomass level set out in Article 6 and above or equal to the minimum spawning biomass level established in Article 6, the fishing mortality rate shall be reduced by 15 % in the year of application of the TAC as compared with the fishing mortality rate in the previous year; and

   (c) if the size of the stock on 1 January of the year of application of the TAC is predicted by STECF to be above or equal to the precautionary spawning biomass level set out in Article 6, the fishing mortality rate shall be reduced by 10 % in the year of application of the TAC as compared with the fishing mortality rate in the previous year.

3. If the application of paragraph 2(b) and (c) would, based on the advice of STECF, result in a fishing mortality rate lower than the fishing mortality rate specified in Article 5(2), the Council shall set the TAC at a level resulting in a fishing mortality rate as specified in that Article.

4. When giving its advice in accordance with paragraphs 2 and 3, STECF shall assume that in the year prior to the year of application of the TAC the stock is fished with an adjustment in fishing mortality equal to the reduction in maximum allowable fishing effort that applies in that year.

5. Notwithstanding paragraph 2(a), (b) and (c) and paragraph 3, the Council shall not set the TAC at a level that is more than 20 % below or above the TAC established in the previous year.

*Article 8*

Procedure for setting TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel

1. Each year, the Council shall decide on the TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel. The TACs shall be calculated by applying the reduction rules set out in Article 7 paragraph 1(a) and (b).

2. The TACs shall initially be calculated in accordance with paragraphs 3 and 5. From the year where the TACs resulting from the application of paragraphs 3 and 5 would be lower than the TACs resulting from the application of paragraphs 4 and 5, the TACs shall be calculated according to the paragraphs 4 and 5.

3. Initially, the TACs shall not exceed a level corresponding to a fishing mortality which is a fraction of the estimate of fishing mortality on appropriate age groups in 2008 as follows: 75 % for the TACs in 2009, 65 % for the TACs in 2010, and applying successive decrements of 10 % for the following years.

4. Subsequently, if the size of the stock on 1 January of the year prior to the year of application of the TACs is:

   (a) above the precautionary spawning biomass level, the TACs shall correspond to a fishing mortality rate of 0,4 on appropriate age groups;

   (b) between the minimum spawning biomass level and the precautionary spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate on appropriate age groups equal to the following formula: 0,4 – (0,2 * (Precautionary spawning biomass level – spawning biomass) / (Precautionary spawning biomass level – minimum spawning biomass level))

   (c) at or below the limit spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate of 0,2 on appropriate age groups.

5. Notwithstanding paragraphs 3 and 4, the Council shall not set the TACs for 2010 and subsequent years at a level that is more than 20 % below or above the TACs established in the previous year.

6. Where the cod stock referred to in paragraph 1 has been exploited at a fishing mortality rate close to 0,4 during three successive years, the Commission shall evaluate the application of this Article and, where appropriate, propose relevant measures to amend it in order to ensure exploitation at maximum sustainable yield.

*Article 9*

Procedure for setting TACs in poor data conditions

Where, due to lack of sufficiently accurate and representative information, STECF is not able to give advice allowing the Council to set the TACs in accordance with Articles 7 or 8, the Council shall decide as follows:

(a) where STECF advises that the catches of cod should be reduced to the lowest possible level, the TACs shall be set according to a 25 % reduction compared to the TAC in the previous year;

(b) in all other cases the TACs shall be set according to a 15 % reduction compared to the TAC in the previous year, unless STECF advises that this is not appropriate.

Consequences of ignoring the Management Plan

This Appendix considers the possibility that the management plans for North Sea, West of Scotland and Irish Sea cod are ignored, and either the current trend in F is continued (year-on-year decline of 1.5% per year for North Sea cod) or the current (2010) level of F will remain unchanged into the future (West of Scotland and Irish Sea cod.

Simulations have been carried out by performing stochastic projections under a constant trend in F (NS) or constant level of F (WoS, IS) without any feedback from the management plan, which is effectively ignored. This means that only the OM=cat/M and SR=1/0.5 options in Table ii are needed. Tables 1, 2 and 3 in the main text are repeated below as Tables A4.1, A4.2 and A4.3 respectively for these options.

**Table A4.1. North Sea cod. Summary results for 4 scenarios for the year 2015. The columns labelled "OM" and "SR" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii. Values for the reference points used are given in Table i, and the summary statistics are described in Table iii. Values for SSB, L, D and C are in thousand tons.**

| | OM | SR | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **0.99** | **0.36** | **0.00** | **0.00** | **0.00** | **134** | **128.4** | **46.4** | **176.6** | **0.40** | **0.14** | **0.54** |
| 4 | m | 1 | 0.98 | 0.26 | 0.00 | 0.00 | 0.50 | 126 | 93.0 | 34.1 | 128.4 | 0.31 | 0.11 | 0.42 |
| **7** | **cat** | **0.5** | **0.85** | **0.04** | **0.00** | **0.00** | **0.00** | **94** | **74.6** | **21.9** | **96.7** | **0.40** | **0.14** | **0.54** |
| 10 | m | 0.5 | 0.78 | 0.02 | 0.00 | 0.00 | 0.50 | 87 | 53.5 | 16.1 | 69.9 | 0.31 | 0.11 | 0.42 |

**Table A4.2. West of Scotland cod. Summary results for 4 scenarios for the year 2015. The columns labelled "OM" and "SR" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii. Values for the reference points used are given in Table i, and the summary statistics are described in Table iii. Values for SSB, L, D and C are in thousand tons.**

| | OM | SR | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **0.38** | **0.08** | **0.00** | **0.00** | **0.00** | **11.9** | **2.509** | **5.906** | **8.299** | **0.28** | **0.65** | **0.93** |
| 4 | m | 1 | 0.43 | 0.15 | 0.00 | 0.01 | 0.61 | 12.6 | 1.027 | 1.925 | 2.970 | 0.09 | 0.22 | 0.31 |
| **7** | **cat** | **0.5** | **0.02** | **0.00** | **0.00** | **0.00** | **0.00** | **6.0** | **1.398** | **2.479** | **3.957** | **0.28** | **0.65** | **0.93** |
| 10 | m | 0.5 | 0.08 | 0.00 | 0.00 | 0.01 | 0.61 | 6.6 | 0.597 | 0.843 | 1.457 | 0.09 | 0.22 | 0.31 |

**Table A4.3. Irish Sea cod. Summary results for 4 scenarios for the year 2015. The columns labelled "OM" and "SR" refer to the different permutations of the assumptions underlying the simulations, as explained in Table ii. Values for the reference points used are given in Table i, and the summary statistics are described in Table iii. Values for SSB, L, D and C are in thousand tons.**

| | OM | SR | Prob $\geq B_{lim}$ | Prob $\geq B_{pa}$ | Prob $\leq F_{msylo}$ | Prob $\leq F_{msy}$ | Prob $\leq F_{msyhi}$ | SSB | L | D | C | FL | FD | FC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **cat** | **1** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **2.4** | **2.544** | **0.000** | **2.544** | **1.39** | **0.00** | **1.39** |
| 4 | m | 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 2.6 | 0.908 | 0.000 | 0.908 | 0.46 | 0.00 | 0.46 |
| **7** | **cat** | **0.5** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **1.2** | **1.211** | **0.000** | **1.211** | **1.39** | **0.00** | **1.39** |
| 10 | m | 0.5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 1.3 | 0.447 | 0.000 | 0.447 | 0.46 | 0.00 | 0.46 |

# Annex 14 Evaluation of measures employed in Scotland under the management plan for cod stocks Article 13 provision during 2010

**Results collated by Marine Scotland Science**

**Introduction**

The Council Regulation (Council Reg. 1342/2008) applying in 2009 continued in 2010 with the provision for Member States to employ alternative measures under Article 13 so long as they delivered equivalent fishing mortality reductions to those specified in the management plan for cod stocks. In Scotland the Conservation Credits Scheme, an initiative involving industry, NGOs, scientists and government official, provided the framework for delivering a co-management process to achieve the targets.

The use of real time closures as a management measure to avoid catches of unwanted juvenile cod were introduced in Scotland in 2007. During 2008, provisions in the December Council Regulation enabled member states to trial schemes which reduced cod mortality without further effort reductions. The Real Time Closure (RTC) Scheme was expanded and extended to include all cod and a number of gear measures proposed.

STECF reviewed the progress of the scheme in November 2008 concluding that the RTCs offered promise but there were too few in 2008 (15) and that the scheme would need to be expanded considerably and the gear measures actually adopted by fishermen. In 2009 the scheme was expanded considerably and a report of outcomes was submitted in 2010. STECF reviewed this and highlighted the dramatic reduction in discards, concluding that although the targets of the cod plan had note been achieved (or by any other Member States) the measures in place had the potential to deliver the established targets and that they should be extended in the future.

This document summarises results arising from the Scottish Conservation Credits scheme in 2010 during which the RTC scheme was expanded and more vessels opted to use selective gears. Scotland's fleet mainly operates in two regions covered by the cod plan namely North Sea and West of Scotland where the required fishing mortality reductions in 2010 were $0.65F_{2008}$ and 25% respectively.

**Measures in 2010**

Article 13b

In addition to making use of the provision of Article 13c (see below), Scotland has also utilised Article 13b allowing for lesser cuts in fishing effort for vessels which catch less than 5% cod. In 2010, 174 vessels (mostly TR2) were deemed eligible to make use of this provision. During the year, a number of these vessels were sampled by observers and records of the cod catch and total catch were made. Table 1 provides details of the sampling occasions. In 2009, 2 observations out of 14 suggested cod catches of higher than 5% and the average cod catch was 67kg. In 2010, 4 out of 15 vessels exceeded the 5% threshold and the average catch had increased to 301kg per trip. The poorer results in 2010 suggest that some vessels are unable to maintain the low cod catch and that there is a need to reconsider the eligibility of some. Also of concern is the increase in average catch. Based on these observations at least, it seems likely that a not insignificant cod catch may be accumulated by these vessels and an evaluation of this will be carried out. This raises questions about the efficacy of by-catch regulation in a plan designed to control and reduce mortality on cod.

Article 13c – Cod avoidance measures

The Conservation Credits Steering Group agreed to an expanded Conservation Credits Scheme in 2010 with the main objective of meeting the management plan for cod stocks targets. The starting point was a 25% cut in effort in 2009 followed by a further 10% cut in 2010. The scheme then operated with two components:

i) A compulsory part involving full observance by all vessels of RTCs. In line with the STECF recommendations these were scaled up and during 2010 it was estimated that 165 closures could deliver the first 20% of the required mortality reduction and days were granted back to vessels in line with this. In July 2010, new data on cod movement arising from cod tagging experiments indicated that an increase in size by 4 times would improve the likelihood of delivering cod catch reductions.

ii) The second part of the scheme was voluntary, involving options to take various selective gears.

The detailed rules applying in the Conservation Credits scheme are set out in Appendix 1.

**Outcomes in 2010**

This section describes some of the out-turn results occurring in 2010. These consist of commentary on some of the individual measures comprising the scheme including, where possible, efforts to quantify effects. This is followed by observations made of the fisheries during the year - notably observations on discards and catch tracking.

*Real Time Closures (RTCs)*

a) RTC implementation

Full details of how the positions for RTCs are determined and of how use is made of fishery dependent data are given in Holmes et al (2009) and Holmes et al (2011)

As a key element for delivering cod avoidance, an effective system for ensuring rapid identification and implementation of RTCs was essential. During 2008 the triggering of RTCs had relied on boardings of vessels by fisheries inspectors and estimates of the catch rate of cod. It was not possible in 2009 or 2010 to deploy resources sufficient to enable the large increases in RTC numbers to be identified by inspections alone. Instead a method was devised utilising landings data linked to VMS information to give estimates of LPUE (landings per 'ping'). The approach isbasically delivers an ongoing routine for identifying RTCs so that at 12 are in place at any one time (each lasts 21 days). A fully integrated management procedure was developed to allow identification, notification and monitoring. Figure 1 shows the overall distribution of RTCs in 2010. There were 165 mostly distributed in a broad arc around the north of Scotland and across the northern part of the North Sea. Note that each closure lasted 21 days and the basic size was 7.5 nm x 7.5nm until July 2010 when the size was increased 4 times (to 15nm x 15nm). When appropriate, the shape of the RTC was adjusted to better match the perceived distribution of cod (for example to align better with the shelf edge or to align with underwater pipelines where fish aggregate).

The general distribution of the RTCs corresponds very well with cod distribution shown in ICES IBTS surveys and also with the distribution of highest cod catch rates as shown in observer trips on board commercial vessels.

b) Analysis of landings

A simple measure of the contribution to cod avoidance is given by a comparison of the landings of vessels operating in the areas which subsequently become RTCs with the landings by the same vessels in the period immediately following the establishment of the RTC when they have moved away. Assuming that if they had continued fishing in the RTC they would have continued to catch similar quantities of fish (in the short term at least) then savings accrue if the vessel moves to areas where the catch rate is less. The greater the differential between the RTC catch rate and the new location the greater the saving. Results in Table 2 show quarterly and annual estimates of catch 'savings' arising from vessels that move away from areas designated as RTCs. Savings are greatest in the North Sea where the majority of closures occurred. Overall the landings saving amounted to around 892 tonnes which, when raised to reflect the discard rate, amount to just over 1177tonnes.

This quantity is less than was predicted would be delivered but it should be noted that the analysis so far takes no account of vessels which simply avoid RTC areas completely so that the 'real effect' of the <u>presence</u> of RTCs may be much greater than implied by the calculated quantities.

Results for the West Coast show only slight savings (39 tonnes when adjusted for discards). This appears to occur because there are fewer opportunities to move away from cod abundant areas since the distributions of other species in the overall fishery occur in similar areas.

c) Analysis of fishermen's behaviour

Another approach used to analyse the effect of RTCs relies on spatial behaviour of fishermen and involves the consideration of movements of individual vessels in response to RTCs. The method is described in Needle and Caterino (2011) and relies on the establishment of a relative cod index of abundance across the North Sea informed by survey and observer data (Figure 2). VMS data are then analysed from individual fishing trips to establish whether vessels move away from RTCs to areas of lower cod abundance or to areas characterised by generally high cod abundance (an example of a track of a vessel is given in Figure 3) Results in Table 3 summarise the findings for 2010 . These show that significant movements away from RTCs to areas of low abundance could be identified in most quarters and for the year as a whole (for boats in RTC areas prior to closure). In 2010 there was evidence of movement towards RTC areas after re-opening. Instances of vessels in RTCs *during* closures were nearly always confined to foreign boats or pelagic vessels

*Spawning closures*

Analysis of the effects of the few small spawning area closures suggested that, based on observed landings from these areas in previous years, their closure contributed only a small amount to reduced cod catches.

*Gear Measures*

The Conservation Credits steering group encouraged development of cod avoidance measures involving selective gears of various types. This was achieved in conjunction with industry and several working meeting were held to identify a suite of gear options offering choices to whitefish (TR1) vessels and *Nephrops* (TR2) vessels. The development involved extensive trialling of novel and modified fishing gears the results of which are too detailed to report in full here but can be found in the accompanying published papers and reports.

In particular, trials were conducted to: i) improve selectivity in TR1 gears through larger meshes generally, square meshed panels SMPs and the introduction of very large meshed panels eg 300mm - 600 mm in the belly of nets ; ii) SMPs in TR2 Nephrops gears and iii) grids based on the 'Swedish Grid'. Trials were carried out by Marine Scotland Science gear technologists using chartered commercial vessels.

Examples of the kinds of gear are shown in Figure 4 and some examples of selectivity results are shown in Figure 5. Based on the relative performance of the different gears in avoiding cod capture, 'a schedule' of effort buy-backs were developed for vessels opting to use one of the options. At this stage, establishing a true 'worth' for each of the gears is not possible.

The text table below provides a summary of the gears being used in 2009 and 2010 and the numbers of vessels involved. Numbers are still low compared to the overall fleet size (160 TR1 Vessels and 300 TR2) but are increasing and represent a major improvement on 2008 when none of the options were taken up. Disappointingly, no vessels are so far using the grid option although interest is growing. It is also unfortunate that only North Sea vessels appear to be taking up gear options, no west coast vessels have so far opted to use these gears.

**North Sea**

| | | | | |
|---|---|---|---|---|
| **2009** | TR1 | | TR2 | |
| | Orkney | 4 | smp | 20 |
| | 130mm | 9 | | |
| | | | | |
| **2010** | TR1 | | TR2 | |
| | Orkney | 25 | smp | 15 |
| | 130mm | 8 | | |

A number of the vessels opting to use the gear options have been sampled by observers and Table 4 provides details of trips on board vessels using either the 130mm cod end mesh, the Orkney trawl or the large meshed square meshed panel (SMP). From these trips it is possible to derive cod catch rates and make two kinds of comparison: a) catch rates prior to the use of the gear (2008) with a period when the gear was in use (2010) and b) to compare the catch rate in 2010 between vessels using the options and the remainder of the fleet. Preliminary calculations of average catch rates across a number of vessels gave mixed results. For two TR1 vessels using the 130mm mesh in 2010 and sampled previously in 2008, there was a reduction in catch rate from 79 kg/hr to 47 k/hr. Similarly, the average of the 5 TR1 vessels using the 130mm sampled in 2010 compared with TR1 boats not using the gear option suggested a lower catch rate in the former group 62.7 compared to 82.7. On the other hand results for the six sampled TR1 vessels using the Orkney trawl in 2010 which were also sampled in 2008 showed a slight increase in 2010 catch rate (70 to 79 kg/hr) and similarly the catch rate of all the sampled 2010 vessels using the Orkney trawl was 98 kg/hr compared to 82.7 for the others. The more limited TR2 sampling also showed higher catch rates in the boats using the SMP gear option.

These observations are very preliminary and cannot be treated as controlled comparisons. For example, they take no account of fishing area, time of year, fishing opportunities (eg the buying in of extra quota which could confound comparison of catch rates, even if the gear effectively reduced catch rates). Furthermore, the comparisons over time take no account of the fact the population biomass increased during this period – all else being equal this would lead to increased catch rates. At present, the comparatively low number of vessels using gear options is unlikely to be contributing significantly to overall mortality changes.

*Discards*

Although it is almost impossible to fully estimate the individual contributions of Conservation Credits measures in the reduction of unwanted cod catches, there are nevertheless key out-turn metrics that provide an indication of the net effect.

Observations of changes in discard rates provide a key indicator of the aggregate effect of the measures employed to encourage cod avoidance. Figures 6 and 7 show the numbers of observations for Scottish vessels in the North Sea and West of Scotland (respectively) using TR1 gears and TR2 gears. Additional sampling between 2008 and 2010 has been possible through additional observers employed to assist the monitoring of Conservation Credits measures generally.

Figures 8 and 9 show a time series of estimates of discard rates in the North Sea for TR1 gear and TR2 gear respectively. Of special note is the rapid decline in discard rate observed in the TR1 gear in the last couple of years. Overall discard quantities and percentage discarded are shown in the text table below. These show that North Sea TR1 discards have dropped to 25% although TR2 figures remain higher. Results for the west coast are much less encouraging with TR1 discard rate at 82% and TR2 at 97% although here the quantities of cod taken by Nephrops gears are lower.

| | | **Marine Scotland Science catch information** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **TR1** | | | **TR2** | | |
| | | landing | discard | discard rate % | landing | discard | discard rate % |
| **COD** | North Sea | 11362 | 3861 | 25 | 436 | 1014 | 70 |
| | West Coast | 108 | 507 | 82 | 5 | 161 | 97 |

*Catch tracking*

Ongoing monitoring of Scottish landings takes place routinely in accordance with management of the Scottish quota – the landings total available to Scotland. In order to inform on progress towards cod recovery targets it is necessary to monitor and track Scottish *catch* (including discards). This is achieved by applying the relevant discard rates for the TR1 and TR2 gears to the relevant landings for these gears and to build up a cumulative picture. In this case the relevant population of vessels used are taken to be those belonging to Scottish producer organisations (POs) . The objective is to remain within the amounts of catch (ie landings + ICES estimate of international discard rate) implied by the ICES forecast and which is allocated to the Scottish POs.

Table 5 summarises the monthly uptake of North Sea catch by the two gear types including the appropriate amounts of discards to provide a cumulative catch. Combining gears gives the Scottish catch.

Figure 10 illustrates the catch trajectory (solid black line + black hatching) against the target values required to meet the Scottish allocation of catch. Results suggest that in 2009 and 2010 the total catch did more or less stay within the bounds implied by available Scottish quota + an allowance for discards equivalent to the ICES estimate of international discard rate *and* stayed well within the prediction of what was required to meet the management plan for cod stocks.

This contrasts markedly with Figure 11 where the discard rate was much higher in 2008 leading to a much higher catch uptake.

Overall, results suggest that a marked improvement (reduction) in discard rate in the TR1 gears has contributed significantly to reducing catches in 2009 and 2010 which were more in line with targets than was the case in 2008.

*Preliminary analysis of Partial F*

Calculation of partial F values provides a way of quantifying the contribution made by different countries or gear groups etc to the overall fishing mortality. In this case the overall F is taken from the 2011 ICES assessment used in its June 2011 advice.

It is also important to note that, strictly speaking, these values can give misleading results if not all countries submit a full set of landings and discard data. Similarly, if the overall TAC is not taken because some countries do not take their full quota, then this can distort the apparent share contributed by each country. Both these issues affect the estimates here.

Table 6 provides preliminary estimates of partial F in the North Sea. Overall assessment results suggest that despite the effort cut (-35% in 2010 compared to 2008) applied under the management plan or the measures under Article 13, overall F has not declined in 2010 to the expected amount (the observed decline is about 3%). Amongst the countries supplying full data, the partial F attributable to Scottish catch has shown only a negligible reduction. Further examination of the table shows that this is achieved through the marked reduction in partial F attributable to discards where a roughly 50% reduction in partial F was achieved over the 2 years.

Clearly the uncertainty arising from incomplete data submissions from some member states and the fact that the assessment still contains some unaccounted mortality estimates (not considered here) means that a definitive view on these partial Fs cannot be given. Preliminary signs suggest that positive steps have been made in the right direction in respect of reducing discard mortality to which the measures employed by Scotland under Article 13 may have contributed. At this stage it is not possible to say which measures have contributed most to this reduction or indeed if it arises through a more general behaviour towards cod avoidance brought about by the Conservation Credits scheme.

**Conclusions**

a) A synthesis is presented of observations during Conservation Credits regime in 2010

b) It is not possible to evaluate fully the effects of individual measures although exploratory analysis of RTC information suggests that these have led to reductions in North Sea cod catch through changes in behaviour and fishermen moving to lower cod abundance areas.

c) There has been a marked reduction in North Sea cod discards in 2010 relative to 2008 and 2009 largely through changes in the TR1 gears. TR2 discard rates remain disappointingly high and greater overall reductions could be achieved in this gear – possibly through the adoption of technical solutions.

d) The reduction in discards translates to a marked reduction in the fishing mortality attributable to discards, although at this stage uncertainties in the assessment and incomplete data from some countries confound the estimation process.

e) The positive direction of travel should be built on and the approach strengthened in order to further enhance cod avoidance. This happened in 2010 with the agreement by the Conservation Credits Steering Group to increase the size of individual RTCs by 4 times following recent analysis of cod tagging data which has provided new information of cod movement. The more recent initiative of catch quotas and fully documented fisheries should further assist in enabling cod catches to be controlled in line with cod plan targets.

f) Results for the West Coast of Scotland are more disappointing. There is little evidence of reduction in cod being caught and discard rates remain high in both the TR1 and TR2 fleets. Furthermore vessels have not taken up Conservation Credits options to use cod avoidance gears. Unfortunately the lack of an ICES assessment providing estimates of fishing mortality precludes a more detailed analysis although the assessment indicative of trends suggest that total mortality has remained high. The trends also suggest some improvement in biomass in the last few years but for this to continue, effective reduction of mortality is required.

**References**

S. J. Holmes, N. Campbell, C. Aires, P. G. Fernandes, R. Catarino, N. Bailey & K. Barratt. 2009. Using VMS and Fishery Data in a Real Time Closure Scheme as a Contribution to Reducing Cod Mortality and Discards. **ICES CM 2009/M:13**

Holmes et al 2011. Using fishery dependent data to inform the development and operation of a co-management inititive to reduce cod mortality and cut discards**. ICES Journal Marine Science 68 (in press)**

C. Needle and R. Caterino, 2011. Evaluating the effect of real-time closures on cod targeting. **ICES Journal Marine Science 68 (in press)**

**Table 1 Observer sampling of vessels granted the <5% cod catch provision in 2009 and 2010. Information is provided on cod catch, overall fish catch, and Nephrops catch – the % of cod actually observed is given in the far right hand column. Note that the vessels numbers apply in both tables (ie some vessels sampled more than once)**

**2009** **Observer sampling of boats under Article 13b (<5% cod in catches)**

| | | | effort | | | | | cod | cod | estimated | | | live | tails | Disc | prop disc | Total Wt | Total | % cod |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| date | Vessel | mesh size | hours | days | stat rec | FU | depth | discarded | landed | fish catch | fish landed | discarded | Nephrops | Nephrops | Nephrops | Nephrops | Nephrops | Catch | |
| | | | | | | | | | | | | | | (raised to L) | | | | | |
| 26/01/2009 | 1 | 80 | 34.08 | 4 | 46E8 | 7 | 110 | 56 | 124.3 | 9568 | 3200 | 6368 | 945 | 252 | 33.22 | 0.027 | 1230.216 | 10798.22 | 1.7 |
| 04/03/2009 | 2 | 70 | 21.33 | 2 | 40E5 | 13 | 65-120 | 10 | 36.2 | 248 | 80 | 168 | 504 | 90 | 55.18 | 0.085 | 649.1803 | 897.1803 | 5.1 |
| 27/03/2009 | 3 | 80 | 28.72 | 2 | 47E9 | 7 | 110-140 | 71 | 0 | 3530 | 692 | 2838 | 494 | 636 | 31.36 | 0.027 | 1161.357 | 4691.357 | 1.5 |
| 02/04/2009 | 5 | 80 | 21.17 | 2 | 41E7 | 8 | 45 | 32 | 0 | 435.2 | 0 | 435.2 | 250 | 951 | 195.51 | 0.14 | 1396.512 | 1831.712 | 1.7 |
| 22/04/2009 | 4 | 80 | 25.67 | 2 | 44E3 | 11 | 80-160 | 2 | 4.4 | 560 | 48 | 512 | 419.1 | 762 | 82.11 | 0.065 | 1263.209 | 1823.209 | 0.4 |
| 14/05/2009 | 6 | 80 | 20.17 | 2 | 40E5 | 13 | 55-85 | 0 | 5.3 | 104 | 16 | 88 | 55 | 156 | 19.60 | 0.085 | 230.6011 | 334.6011 | 1.6 |
| 15/05/2009 | 12 | 95 | 13.57 | 2 | 42F0 | 1 | 145 | 10 | 157 | 516 | 335 | 181 | 123.5 | 48 | 4.76 | 0.027 | 176.259 | 692.259 | 24.1 |
| 06/06/2009 | 7 | 80 | 85.18 | 7 | 45F1 | 7 | 110-140 | 88 | 34.1 | 3528 | 1576 | 1952 | 3832 | 1980 | 161.28 | 0.027 | 5973.279 | 9501.279 | 1.3 |
| 06/08/2009 | 11 | 80 | 26.0 | 4 | 40E4 | 13 | 45-85 | 0 | 0 | 33 | 0 | 33 | 483 | 0 | 44.87 | 0.085 | 527.8689 | 560.8689 | 0.0 |
| 28/08/2009 | 8 | 80 | 3.0 | 1 | 42E7 | 8 | 62 | 2 | 0 | 257.6 | 1.6 | 256 | 88 | 0 | 14.33 | 0.14 | 102.3256 | 359.9256 | 0.6 |
| 23/09/2009 | 9 | 80 | 34.22 | 4 | 44E7 | 9 | 80-200 | 86 | 0 | 2136 | 248 | 1888 | 591 | 414 | 31.08 | 0.03 | 1036.082 | 3172.082 | 2.7 |
| 30/09/2009 | 10 | 80 | 35 | 3 | 39E4 | 13 | 45-65 | 0 | 0 | 592 | 0 | 592 | 608 | 2565 | 294.76 | 0.085 | 3467.76 | 4059.76 | 0.0 |
| 09/12/2009 | 10 | 80 | 26.5 | 3 | 39E5 | 13 | 55-117 | 7 | 0 | 640 | 0 | 640 | 480 | 642 | 104.23 | 0.085 | 1226.23 | 1866.23 | 0.4 |
| 12/12/2009 | 8 | 80 | 15.75 | 3 | 42E7 | 8 | 55-85 | 181 | 36.9 | 744 | 40 | 704 | 305 | 57 | 58.93 | 0.14 | 420.9302 | 1164.93 | 18.7 |

**2010** **Observer sampling of boats under Article 13b (<5% cod in catches)**

| | | | effort | | | | | cod | cod | estimated | | | live | tails | Disc | prop disc | Total Wt | Total | % cod |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| date | Vessel | mesh size | hours | days | stat rec | FU | depth | discarded | landed | catch | marketable | discarded | prawns | prawns | Prawns | nephrops | Prawns | Catch | |
| 16/03/2010 | 17 | 100 | 58 | 3 | 50F1 | 7 | 120-150 | 217 | 0 | 5334.5 | 2999.1 | 2235.4 | 354.92 | 1117.5 | 40.86 | 0.027 | 1513.279 | 6847.779 | 3.2 |
| 24/03/2010 | 6 | 80 | 22.75 | 2 | 39E5 | 13 | 60-75 | 2 | 48.4 | 148.8 | 65.6 | 83.2 | 139 | 306 | 41.34 | 0.085 | 486.3388 | 635.1388 | 7.9 |
| 09/04/2010 | 10 | 80 | 21.58 | 3 | 39E5 | 13 | 50-100 | 0 | 0 | 560 | 0 | 560 | 373 | 606 | 90.95 | 0.085 | 1069.945 | 1629.945 | 0.0 |
| 10/04/2010 | 8 | 80 | 26.22 | 3 | 42E7 | 8 | 55-75 | 6 | 0 | 296 | 0 | 296 | 252 | 0 | 51.61 | 0.17 | 303.6145 | 599.6145 | 1.0 |
| 16/04/2010 | 15 | 80 | 135.08 | 9 | 45F1 | 7 | 115-140 | 642 | 75 | 14800 | 10000 | 4900 | 3348 | 3360 | 186.14 | 0.027 | 6894.142 | 21694.14 | 3.3 |
| 16/05/2010 | 13 | 80 | 121 | 7 | 44F0 | 7 | 115-145 | 133 | 90 | 3425.9 | 1824 | 1602 | 4380 | 2376 | 187.47 | 0.027 | 6943.474 | 10369.37 | 2.2 |
| 05/06/2010 | 9 | 80 | 41.95 | 3 | 45F0 | 7 | 120-135 | 191 | 24.8 | 1920 | 500.6 | 1418 | 289 | 4731 | 139.30 | 0.027 | 5159.301 | 7079.301 | 3.0 |
| 08/06/2010 | 14 | 80 | 141.54 | 9 | 46E9 | 7 | 100-130 | 413 | 20 | 5048 | 2040 | 3008 | 1785 | 2025 | 105.72 | 0.027 | 3915.725 | 8963.725 | 4.8 |
| 03/08/2010 | 18 | 80 | 27 | 2 | 41E4 | 12 | 55-100 | 2 | 0 | 329.9 | 0 | 329.9 | 308 | 1125 | 65.95 | 0.044 | 1498.954 | 1828.854 | 0.1 |
| 05/08/2010 | 10 | 80 | 32.33 | 2 | 39E5 | 13 | 45-80 | 1 | 0 | 440 | 0 | 440 | 448 | 1617 | 191.83 | 0.085 | 2256.831 | 2696.831 | 0.0 |
| 08/08/2010 | 19 | 80 | 32.94 | 4 | 45F0 | 7 | 130-150 | 527 | 0 | 5045.5 | 825.5 | 4220 | 3420 | 217.5 | 100.94 | 0.027 | 3738.438 | 8783.938 | 6.0 |
| 23/08/2010 | 16 | 80 | 74.5 | 8 | 46F0 | 7 | 130-135 | 951 | 0 | 3120 | 1541 | 1579 | 2254 | 2635 | 135.67 | 0.027 | 5024.666 | 8144.666 | 11.7 |
| 14/09/2010 | 5 | 80 | 28.78 | 3 | 41E7 | 8 | 40-50 | 6 | 0 | 291.2 | 0 | 291.2 | 137.5 | 1237.5 | 281.63 | 0.17 | 1656.627 | 1947.827 | 0.3 |
| 22/10/2010 | 5 | 80 | 26.17 | 2 | 41E7 | 8 | 40-50 | 181 | 0 | 707.2 | 0 | 707.2 | 237.5 | 487.5 | 148.49 | 0.17 | 873.494 | 1580.694 | 11.5 |
| 24/10/2010 | 13 | 80 | 90.25 | 8 | 45F1 | 7 | 120-140 | 372 | 315 | 7725 | 1994 | 5731 | 3901 | 4257 | 226.38 | 0.027 | 8384.378 | 16109.38 | 4.3 |

**Table 2 Landings of cod by vessels associated with RTCs before closure, and during the closures. Differences are taken to indicate landings savings which are raised by the discard rate to indicate catch savings.**

a) North sea

North Sea

| | Pre-RTC | During RTC | Difference | "Catch" difference |
|---|---|---|---|---|
| Annual | 3917 | 3025 | 892 | **1177** |
| Q1 | 636 | 504 | 132 | **174** |
| Q2 | 810 | 719 | 91 | **120** |
| Q3 | 1618 | 1142 | 476 | **629** |
| Q4 | 853 | 661 | 192 | **254** |

b)West Coast

West coast

| | Pre-RTC | During RTC | Difference | "Catch" difference |
|---|---|---|---|---|
| Annual | 425.8 | 405.39 | 20.41 | **39** |
| Q1 | 101.96 | 97.04 | 4.92 | **9** |
| Q2 | 148.99 | 145.01 | 3.98 | **8** |
| Q3 | 81.46 | 95.26 | -13.8 | **-26** |
| Q4 | 93.39 | 68.08 | 25.31 | **49** |

**Table 3 Means of trip RCII differences, for different quarters (rows) and categories of event (columns). . Means which are significantly different to zero (according to the *t*-test results in parentheses) are highlighted in bold font. Negative values signify movement away from RTCs .**

| **b)** | before | | during | | after | |
|---|---|---|---|---|---|---|
| all | **-0.053** | (p = 0) | **-0.027** | (p = 0.002) | **0.057** | (p = 0) |
| q1 | -0.014 | (p = 0.136) | -0.027 | (p = 0.074) | **0.026** | (p = 0.009) |
| q2 | **-0.036** | (p = 0.002) | 0.009 | (p = 0.68) | **0.036** | (p = 0) |
| q3 | **-0.072** | (p = 0) | **-0.047** | (p = 0.001) | **0.065** | (p = 0) |
| q4 | **-0.07** | (p = 0) | -0.026 | (p = 0.22) | **0.079** | (p = 0) |

**Table 4**

**Observed vessels using Conservation Credits gear options: Cod catch, effort and CPUE**

| | | 2008 | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gear option | Vessel No.** | CATCH (KG) | EFFORT (HRS) | CPUE | CATCH (KG) | EFFORT (HRS) | CPUE | CATCH (KG) | EFFORT (HRS) | CPUE |
| TR1_level 1_130MM CODEND | 1 | | | | | | | 7716 | 94 | 82.09 |
| TR1_level 1_130MM CODEND | 2 | 7028.1 | 62.92 | 111.70 | | | | 2929.34 | 86.25 | 33.96 |
| TR1_level 1_130MM CODEND | 3 | | | | 4387.2 | 65.67 | 66.81 | 23192.2 | 241.38 | 96.08 |
| TR1_level 1_130MM CODEND | 4 | 3897.25 | 75.58 | 51.56 | 8462.45 | 133.2 | 63.53 | 3324.55 | 46.25 | 71.88 |
| TR1_level 1_130MM CODEND | 5 | | | | 3904.35 | 157.3 | 24.82 | 8130.16 | 254.42 | 31.96 |
| TR1_Level 3_Orkney Trawl | 1 | 9078.31 | 195.18 | 46.51 | 11306.16 | 154.75 | 73.06 | 21461.35 | 338.5 | 63.40 |
| TR1_Level 3_Orkney Trawl | 2 | 11640.1 | 123.98 | 93.89 | 680.12 | 110.75 | 6.14 | 10998 | 74.03 | 148.56 |
| TR1_Level 3_Orkney Trawl | 3 | | | | | | | 6466.23 | 122 | 53.00 |
| TR1_Level 3_Orkney Trawl | 4 | 93.97 | 18.22 | 5.16 | 3265.95 | 156.83 | 20.82 | 8152 | 108.83 | 74.91 |
| TR1_Level 3_Orkney Trawl | 5 | 0 | 116 | 0.00 | 6601.08 | 125.53 | 52.59 | 10368.43 | 75 | 138.25 |
| TR1_Level 3_Orkney Trawl | 6 | 3904.5 | 145 | 26.93 | 27964.5 | 280 | 99.87 | 22411.1 | 297.83 | 75.25 |
| TR1_Level 3_Orkney Trawl | 7 | | | | | | | 18128.9 | 77 | 235.44 |
| TR1_Level 3_Orkney Trawl | 8 | | | | 554.65 | 129 | 4.30 | 6544.6 | 163.75 | 39.97 |
| TR1_Level 3_Orkney Trawl | 9 | | | | | | | 8910.31 | 121.17 | 73.54 |
| TR1_Level 3_Orkney Trawl | 10 | | | | | | | 6852.15 | 108.83 | 62.96 |
| TR1_Level 3_Orkney Trawl | 11 | | | | | | | 29253.15 | 162.65 | 179.85 |
| TR1_Level 3_Orkney Trawl | 12 | 7969 | 122.5 | 65.05 | 40193.79 | 172.17 | 233.45 | 18912.19 | 246.5 | 76.72 |
| TR1_Level 3_Orkney Trawl | 13 | | | | | | | 14010.87 | 155.67 | 90.00 |
| TR1_Level 3_Orkney Trawl | 14 | | | | 234.56 | 14.25 | 16.46 | 2237.89 | 23.92 | 93.56 |
| TR1_Level 3_Orkney Trawl | 15 | | | | | | | 15626.68 | 152.83 | 102.25 |
| TR1_Level 3_Orkney Trawl | 16 | 14894.6 | 71.5 | 208.32 | | | | 6450.9 | 48.42 | 133.23 |
| TR1_Level 3_Orkney Trawl | 17 | | | | | | | 15874.66 | 49 | 323.97 |
| TR1_Level 3_Orkney Trawl | 18 | | | | | | | 10981.44 | 48 | 228.78 |
| TR2_Level 1_SMP | 1 | | | | 303 | 121.6 | 2.49 | 145.4 | 75.5 | 1.93 |
| TR2_Level 1_SMP | 2 | 3218.7 | 441.9 | 7.28 | 1363.1 | 141.75 | 9.62 | 2677.1 | 146.75 | 18.24 |
| TR2_Level 1_SMP | 3 | | | | 543.1 | 67.58 | 8.04 | 2015.79 | 134.93 | 14.94 |
| TR2_Level 1_SMP | 4 | | | | | | | 4400.97 | 170.75 | 25.77 |
| TR2_Level 1_SMP | 5 | | | | | | | 1958.88 | 81.75 | 23.96 |
| TR2_Level 1_SMP | 6 | | | | | | | 4179.39 | 169.12 | 24.71 |
| TR2_Level 1_SMP | 7 | | | | 2051.8 | 272.17 | 7.54 | 466.01 | 117.5 | 3.97 |
| TR2_Level 1_SMP | 8 | | | | 550.61 | 126.28 | 4.36 | 581.86 | 136.67 | 4.26 |

** Note numbering applies within each group. No vessels in more than one group.

**Table 5 North Sea monthly uptake of cumulative catch (Scottish PO vessels) and discard proportion building towards the annual total for TR1 above and TR2 below. Coloured shading indicates green – rate below the notional international discard rate implied by ICES forecasts, orange – above the international rate but below 50%, red - above 50%.**

| month | %dis | cum catch | cum dis | %cum dis |
|---|---|---|---|---|
| jan | 33.0% | 894 | 295 | 33.0% |
| feb | 33.0% | 1987 | 655 | 33.0% |
| mar | 33.0% | 3011 | 993 | 33.0% |
| apr | 19.3% | 3962 | 1176 | 29.7% |
| may | 19.3% | 5292 | 1433 | 27.1% |
| jun | 19.3% | 6746 | 1713 | 25.4% |
| jul | 23.5% | 8094 | 2030 | 25.1% |
| aug | 23.5% | 9278 | 2308 | 24.9% |
| sep | 23.5% | 10119 | 2506 | 24.8% |
| oct | 41.3% | 11258 | 2976 | 26.4% |
| nov | 41.3% | 12762 | 3596 | 28.2% |
| dec | 41.3% | 13757 | 4007 | 29.1% |

| month | %dis | cum catch | cum dis | %cum dis |
|---|---|---|---|---|
| jan | 90.8% | 275 | 250 | 90.8% |
| feb | 90.8% | 635 | 576 | 90.8% |
| mar | 90.8% | 823 | 747 | 90.8% |
| apr | 65.6% | 880 | 784 | 89.2% |
| may | 65.6% | 943 | 826 | 87.6% |
| jun | 65.6% | 1012 | 871 | 86.1% |
| jul | 90.4% | 1359 | 1185 | 87.2% |
| aug | 90.4% | 1834 | 1614 | 88.0% |
| sep | 90.4% | 2204 | 1949 | 88.4% |
| oct | 17.5% | 2250 | 1957 | 87.0% |
| nov | 17.5% | 2293 | 1964 | 85.7% |
| dec | 17.5% | 2320 | 1969 | 84.9% |

**Table 6 Partial Fs (preliminary) calculated by partitioning Fs (mean 2-4) arising from 2011 ICES assessment (shown in right hand column) according to countries landings, discards and catch (based on numbers of fish).**

| 2008 | Denmark | Scotland | Germany | E&W | Netherlands | Sweden | Norway | Belgium | France | Faroes | Total F |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Landings | 0.0925 | 0.0911 | 0.0295 | 0.0247 | 0.0161 | 0.0119 | 0.0578 | 0.0110 | 0.0202 | 0.0002 | |
| Discards | 0.0627 | 0.1564 | 0.0009 | 0.0033 | 0.0335 | 0.0031 | 0.0477 | 0.0135 | 0.0221 | 0.0006 | |
| Catch | 0.1552 | 0.2475 | 0.0304 | 0.0280 | 0.0496 | 0.0150 | 0.1055 | 0.0245 | 0.0423 | 0.0008 | 0.6987 |
| **2009** | | | | | | | | | | | |
| Landings | 0.0962 | 0.1204 | 0.0266 | 0.0366 | 0.0399 | 0.0123 | 0.0499 | 0.0139 | 0.0241 | 0.0006 | |
| Discards | 0.0621 | 0.1094 | 0.0023 | 0.0079 | 0.0220 | 0.0038 | 0.0327 | 0.0083 | 0.0140 | 0.0004 | |
| Catch | 0.1582 | 0.2299 | 0.0288 | 0.0445 | 0.0620 | 0.0161 | 0.0826 | 0.0222 | 0.0382 | 0.0010 | 0.6833 |
| **2010** | | | | | | | | | | | |
| Landings | 0.1378 | 0.1694 | 0.0466 | 0.0271 | 0.0293 | 0.0128 | 0.0399 | 0.0091 | 0.0260 | 0.0004 | |
| Discards | 0.0524 | 0.0771 | 0.0010 | 0.0024 | 0.0110 | 0.0019 | 0.0195 | 0.0030 | 0.0097 | 0.0001 | |
| Catch | 0.1901 | 0.2465 | 0.0476 | 0.0295 | 0.0403 | 0.0146 | 0.0594 | 0.0121 | 0.0357 | 0.0006 | 0.6763 |

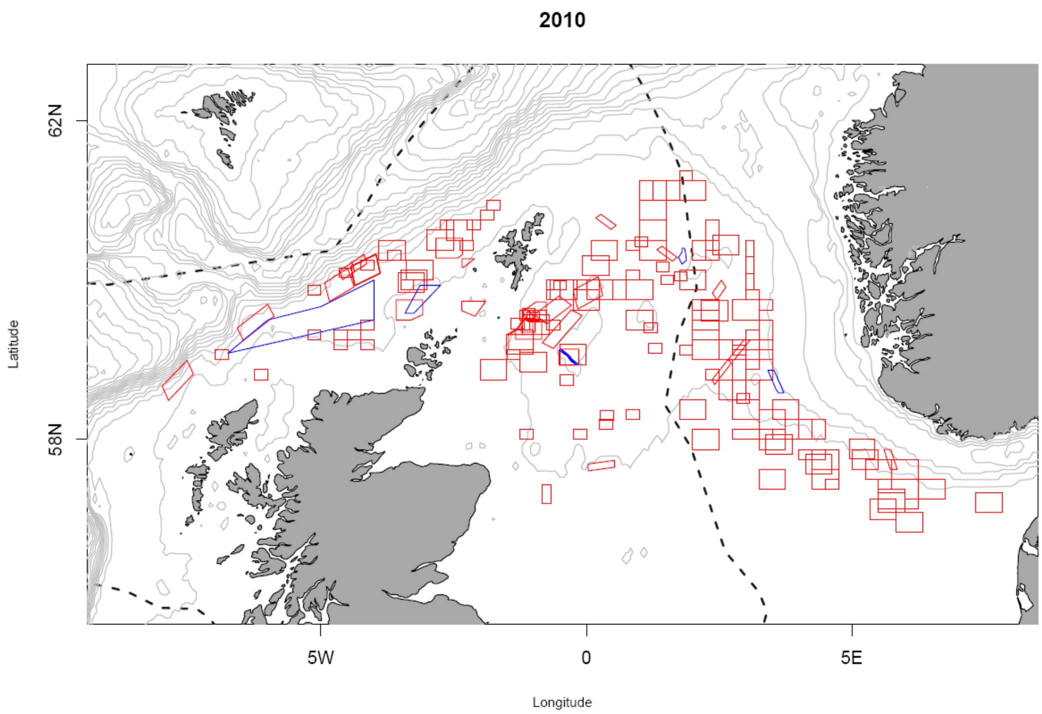



**Figure 1 Distribution of RTCs (red polygons) and seasonal closures (blue) in 2010. Note the existing permanent large west coast closure is also shown**

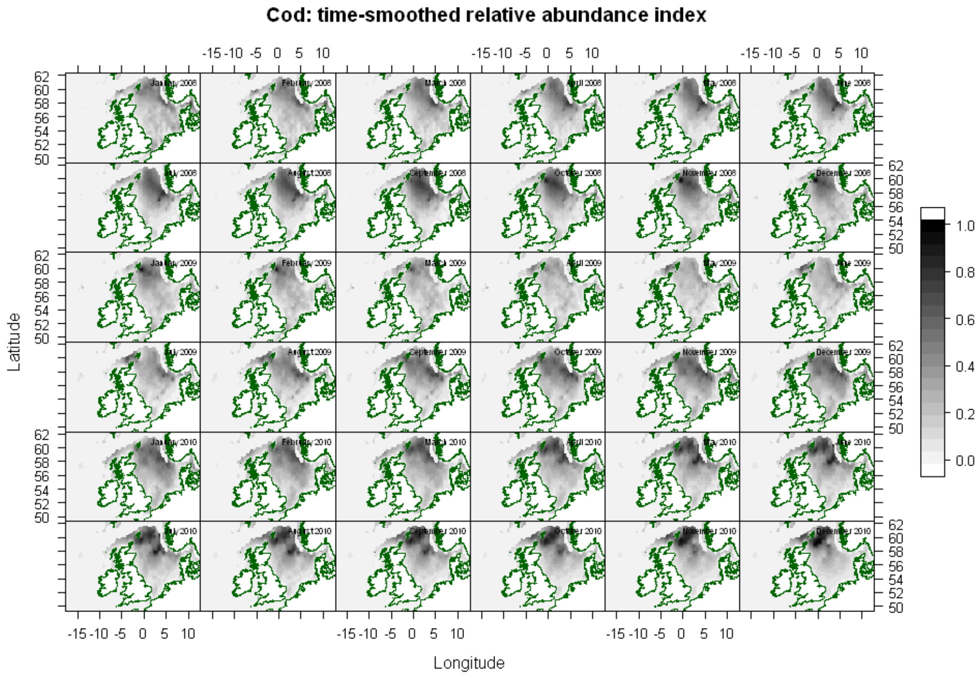



**Figure 2 Relative abundance index for cod shown by month for 2008 and 2009**

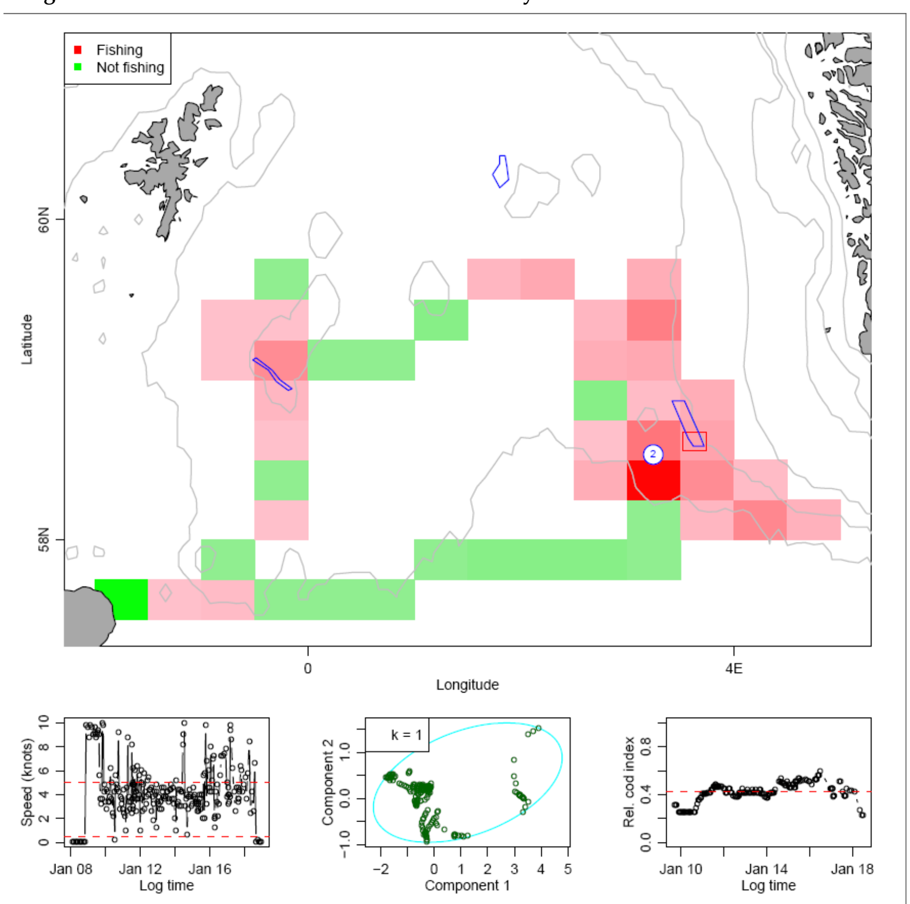
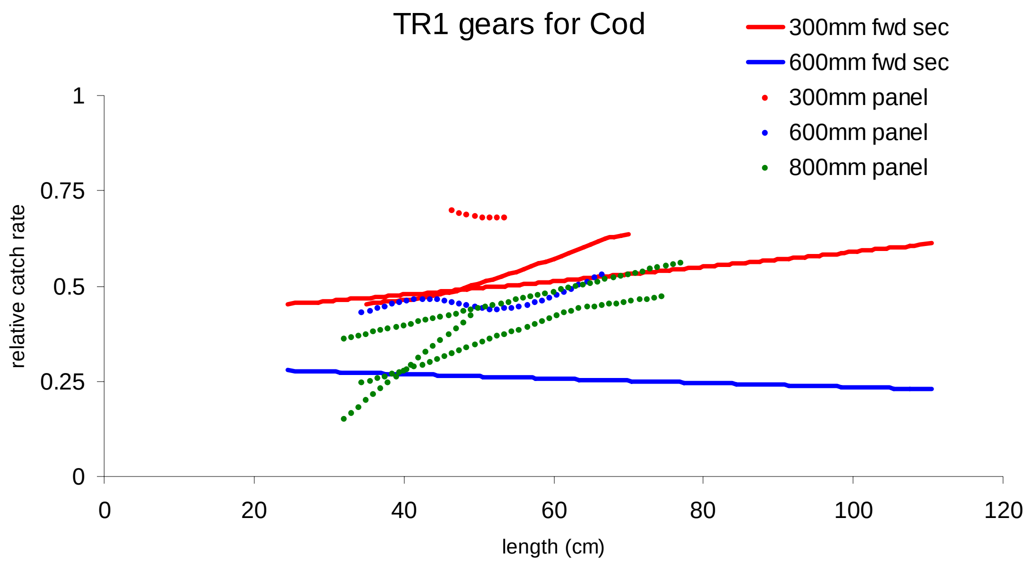



**Figure 3  Individual track of vessel during one fishing trip. Red square shows position of an RTC ) probably triggered by the vessel shown. Spawning areas are shown in blue.**

**Figure 4 Gear trial work showing large meshes near the entrance to the net in the Orkney trawl (above), and 200mm square meshed panel below.**



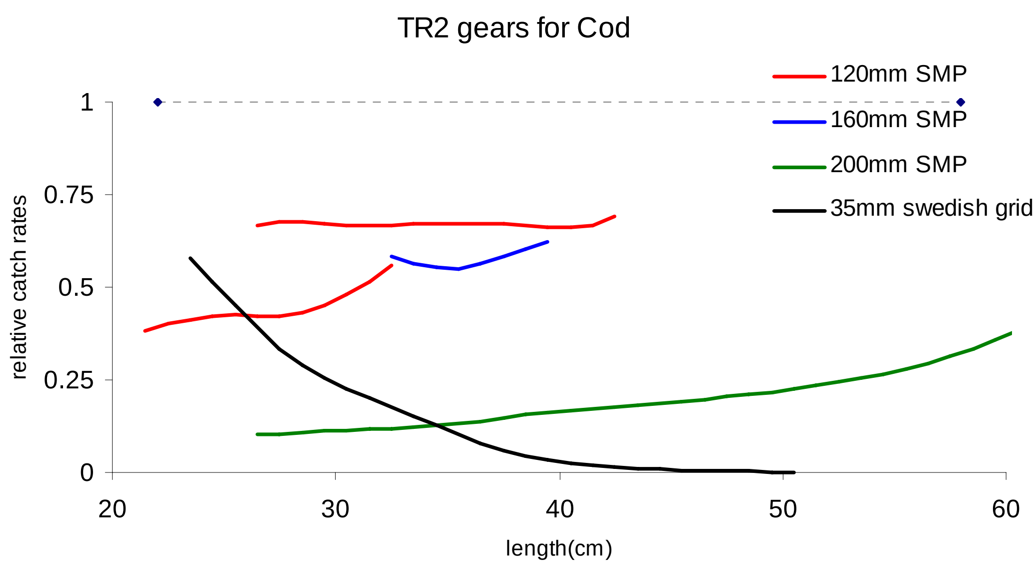




**Figure 5 Selectivity results (top figure) for various configurations of large mesh (placed in the forward section of the net or as large panels in the belly of the net) all designed to reduce cod catch. Values of 1 would signify no difference from a small meshed control. Across a range of lengths cod catch rate is reduced significantly; (bottom figure) comparing various square meshed panel types and the Swedish grid. The large meshed 200mm SMP shows particularly good reductions at small sizes of fish but only the grid reduces catches of larger fish effectively.**

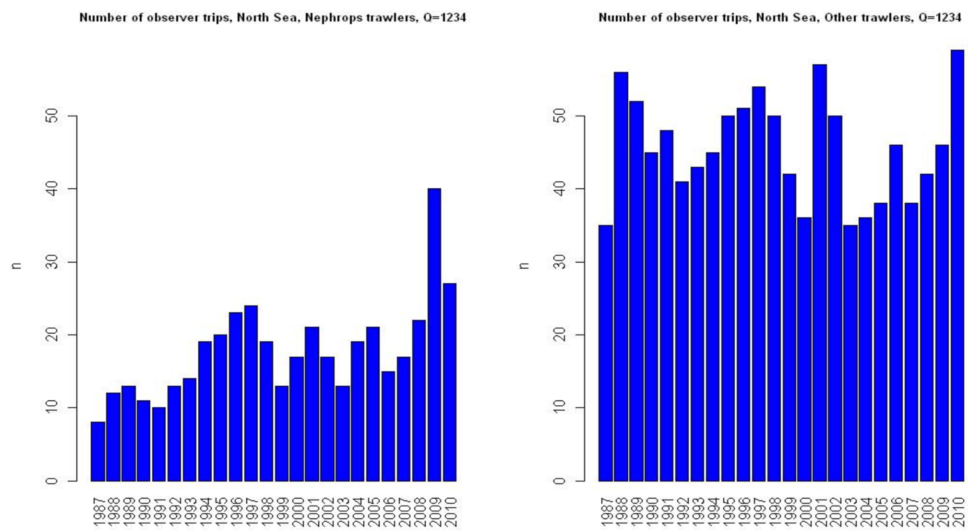



**Figure 6 North Sea Observer trip numbers**

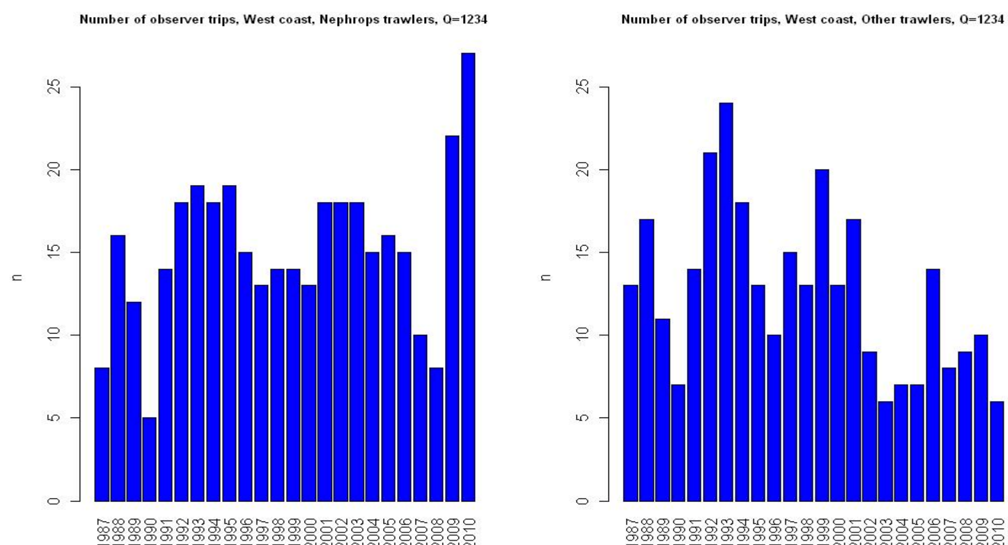



**Figure 7 West Coast Observer trip numbers**

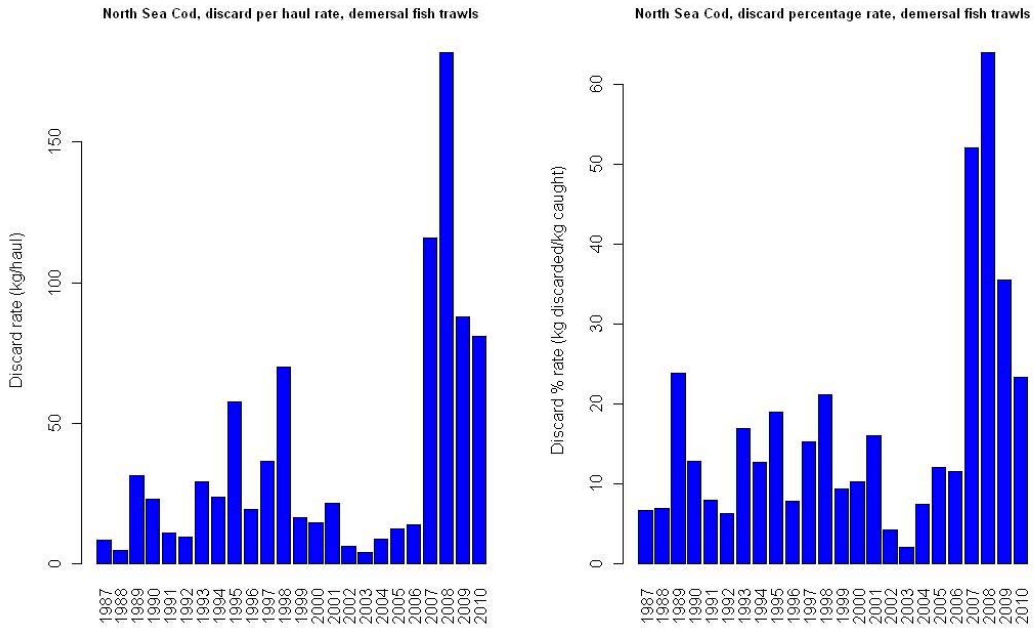



**Figure 8 Observer results for TR1 gears in North Sea showing discard rates expressed as kg/haul (left side) and % cod discarded of total cod (right side).**

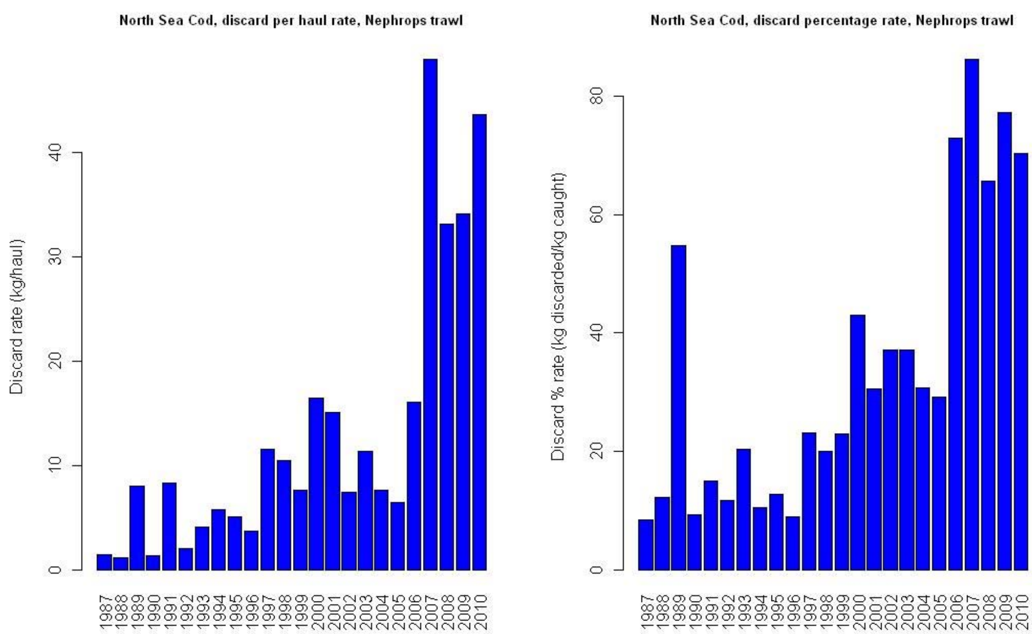



**Figure 9 Observer results for TR2 gears in North Sea (blue) and west coast (red) showing discard rates expressed as kg/haul (left side) and % cod discarded of total cod (right side). Quarterly results 2008 and 2009**

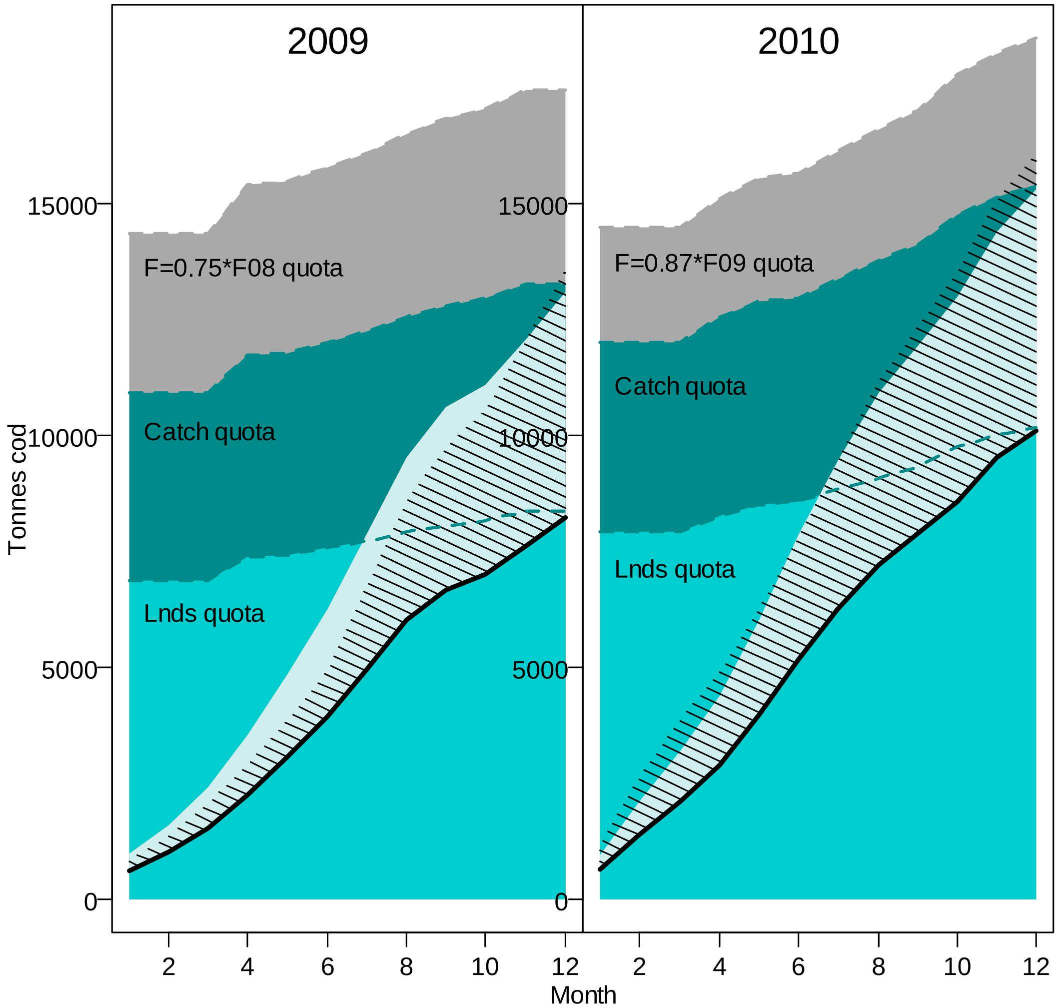



**Figure 10 Cod catch trajectory in 2009 2010. Horizontal shaded bands represent Scottish landings quota - pale blue - (based on producer organisation total), additional amount representing ICES prediction of international discard rate – dark blue- and overall 'Scottish catch' predicted by ICES forecast of cod recovery plan target –dark grey-. Solid black line represents landings uptake by Scotland , pale grey additional amount implied by international discard rate and hatched area the observed discards (as per Table 4)**

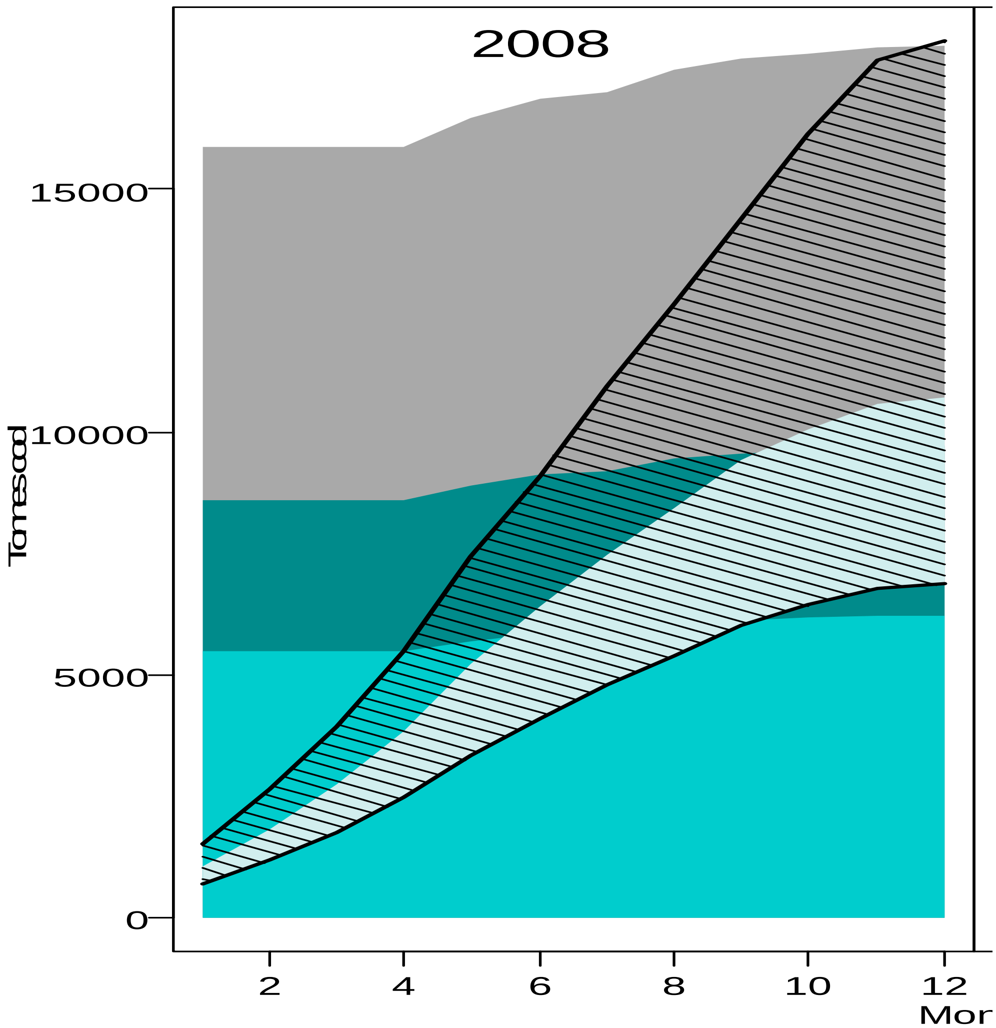



**Figure 11 Cod catch trajectory in 2008. details as per legend above**

# Annex 15 Tables for Social and Economic Effects of the North Sea Cod Plan

Sasha Maguire Marine Scotland Edinburgh, UK

Table: comparison of fleets selected for analysis against all available fleets

| Total, all fleets | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|
| Employment (FTE) | 22471 | 22190 | 20607 | 17926 |
| Fleet number | 13512 | 13747 | 12847 | 12362 |
| Value North Sea cod landings (euro, m) | 98.41 | 95.99 | 58.23 | 61.93 |

| Total, selected fleets | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|
| Employment (FTE) | 9524 | 8821 | 8336 | 7476 |
| Fleet number | 3659 | 3409 | 2534 | 2381 |
| Value North Sea cod landings (euro, m) | 87.16 | 83.44 | 54.57 | 55.75 |

| Selected fleets % of total | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|
| Employment (FTE) | 42% | 40% | 40% | 42% |
| Fleet number | 27% | 25% | 20% | 19% |
| Value North Sea cod landings (euro) | 89% | 87% | 94% | 90% |

Table : Selected fleets, North Sea Cod Dependence: % fleet total fishing revenue from NS cod

| Member State | Fishing method* | Vessel Length (m) | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| Belgium | TBB | 24-40 | 13% | 13% | 6% | 5% |
| Germany | DTS | 12-24 | 15% | 11% | 7% | 8% |
| Germany | DTS | over 24 | 27% | 24% | 21% | 25% |
| Denmark | DTS | 12-24 | 30% | 31% | 11% | 12% |
| Denmark | PGP | 00-12 | 46% | 43% | 31% | 22% |
| Denmark | PGP | 12-24 | 29% | 29% | 26% | 28% |
| Denmark | PMP | 00-12 | 45% | 43% | 18% | 15% |
| Denmark | PMP | 12-24 | 27% | 31% | 21% | 22% |
| Denmark | PTS | 24-40 | 5% | 9% | 8% | 8% |
| France | DTS | 12-24 | 9% | 8% | na | 7% |
| France | DTS | 24-40 | 8% | 10% | na | 5% |
| UK | DFN | 12-24 | 87% | 75% | 91% | 87% |
| UK | DTS | 12-24 | 6% | 6% | 5% | 6% |
| UK | DTS | 24-40 | 14% | 14% | 12% | 14% |
| UK | DTS | over 40 | 6% | 6% | 8% | 7% |
| Netherlands | DTS | 24-40 | 3% | 4% | 3% | 5% |
| Netherlands | TBB | 12-24 | 1% | 1% | 1% | 1% |
| Netherlands | TBB | 24-40 | 1% | 1% | 2% | 2% |
| Netherlands | TBB | over 40 | 1% | 1% | 2% | 2% |
| All selected segments | | | 12% | 11% | 7% | 9% |

*see annex table below list of DCF fishing methods

Table: Selected fleets, totals: Effort

| | 2006 | 2007 | 2008 | 2009 | % change 2006-09 | average per vessel 2006 | average per vessel 2009 |
|---|---|---|---|---|---|---|---|
| Effort days North Sea | 252,318 | 209,781 | 180,464 | 160,935 | -36% | 69 | 83 |
| Effort days Total | 291,862 | 251,261 | 223,483 | 200,112 | -31% | 80 | 103 |
| Effort GT days North Sea | 29,849,071 | 26,956,635 | 22,733,166 | 21,831,002 | -27% | 8,214 | 11,230 |
| Effort GT days Total | 33,020,369 | 30,110,016 | 25,937,229 | 24,949,910 | -24% | 9,087 | 12,834 |
| Effort KW days North Sea | 95,413,826 | 84,973,086 | 67,903,522 | 64,212,319 | -33% | 26,256 | 33,031 |
| Effort KW days Total | 105,906,242 | 95,711,343 | 78,773,193 | 74,503,848 | -30% | 29,143 | 38,325 |

NB: the effort data reported does not include details for the French fleet segments for which effort data is only available for 2009

Table: Selected fleets, total: Income and Costs (EUR)

| | 2006 | 2007 | 2008 | 2009 | % change 2006-09 | average per vessel 2006 | average per vessel 2009 |
|---|---|---|---|---|---|---|---|
| Income | 1,360,831,419 | 1,360,306,354 | 1,240,770,124 | 1,055,790,431 | -22% | 374,472 | 543,102 |
| Costs | | | | | | | |
| Total Costs | 1,320,206,465 | 1,290,252,228 | 1,059,724,258 | 845,808,185 | -36% | 363,293 | 435,087 |
| Capital | 138,044,057 | 124,935,678 | - | - | na | 37,987 | |
| Crew | 423,405,552 | 423,132,914 | 319,965,657 | 284,073,408 | -33% | 116,512 | 146,128 |
| Fixed | 104,672,919 | 103,750,210 | 167,034,091 | 109,709,077 | 5% | 28,804 | 56,435 |
| Fuel | 295,644,568 | 298,383,118 | 331,053,925 | 211,573,095 | -28% | 81,355 | 108,834 |
| Repairs | 124,190,446 | 125,321,625 | 114,339,564 | 110,147,644 | -11% | 34,175 | 56,660 |
| Variable | 234,248,922 | 214,728,682 | 127,331,021 | 130,304,960 | -44% | 64,460 | 67,029 |

Table  Selected fleets, totals: Landings, weight and value (EUR and tons)

| | 2006 | 2007 | 2008 | 2009 | % change 2006-09 | average per vessel 2006 | average per vessel 2009 |
|---|---|---|---|---|---|---|---|
| Value all Landings Total | 729,689,621 | 729,447,669 | 730,809,324 | 639,940,653 | -12% | 200,795 | 329,188 |
| Value all landings, North Sea | 729,193,880 | 728,972,409 | 655,441,945 | 573,286,536 | -21% | 200,659 | 294,900 |
| Value COD North Sea | 87,159,875 | 83,444,710 | 54,566,487 | 55,753,011 | -36% | 23,985 | 28,680 |
| | | | | | | | |
| Weight all Landings Total | 524910 | 392698 | 414105 | 468427 | -11% | 144,444 | 240,960 |
| Weight all landings, North Sea | 524365 | 392115 | 382260 | 433133 | -17% | 144,294 | 222,805 |
| Weight COD North Sea | 37697 | 32070 | 18525 | 24240 | -36% | 10,373 | 12,469 |
| | | | | | | | |
| Implied price/tonne cod | 2,312 | 2,602 | 2,946 | 2,300 | | | |

Table: Selected fleets: value of North Sea Cod (EUR m)

| Member State | Fishing Method | Vessel Length (m) | 2006 | 2007 | 2008 | 2009 | % change 2006-9 |
|---|---|---|---|---|---|---|---|
| Belgium | TBB | 24-40 | 3.04 | 2.55 | 2.24 | 1.55 | -49% |
| Germany | DTS | 12-24 | 1.57 | 1.24 | 0.71 | 0.45 | -72% |
| Germany | DTS | over 24 | 6.18 | 4.83 | 4.14 | 5.29 | -14% |
| Denmark | DTS | 12-24 | 18.69 | 17.19 | 7.09 | 7.13 | -62% |
| Denmark | PGP | 00-12 | 14.07 | 11.88 | 3.57 | 2.08 | -85% |
| Denmark | PGP | 12-24 | 7.89 | 5.35 | 4.13 | 4.17 | -47% |
| Denmark | PMP | 00-12 | 2.85 | 2.86 | 0.62 | 0.39 | -86% |
| Denmark | PMP | 12-24 | 5.44 | 6.23 | 2.77 | 2.28 | -58% |
| Denmark | PTS | 24-40 | 4.18 | 5.34 | 3.89 | 3.86 | -8% |
| France | DTS | 12-24 | 0.44 | 0.53 | 0.00 | 2.20 | 406% |
| France | DTS | 24-40 | 0.28 | 0.48 | 0.00 | 1.34 | 384% |
| UK | DFN | 12-24 | 0.43 | 0.21 | 0.76 | 0.81 | 90% |
| UK | DTS | 12-24 | 6.95 | 8.91 | 8.30 | 8.41 | 21% |
| UK | DTS | 24-40 | 11.93 | 12.35 | 11.44 | 11.44 | -4% |
| UK | DTS | over 40 | 0.35 | 0.33 | 1.04 | 0.89 | 155% |
| Netherlands | DTS | 24-40 | 0.20 | 0.38 | 0.72 | 0.81 | 309% |
| Netherlands | TBB | 12-24 | 0.56 | 0.45 | 0.83 | 0.02 | -96% |
| Netherlands | TBB | 24-40 | 0.38 | 0.36 | 0.46 | 0.53 | 42% |
| Netherlands | TBB | over 40 | 1.75 | 1.98 | 1.89 | 2.09 | 20% |

Table: Proportion of all North Sea cod landed by selected fleets

| Member State | | Vessel Length (m) | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| Belgium | TBB | 24-40 | 3.1% | 2.7% | 3.8% | 2.5% |
| Germany | DTS | 12-24 | 1.6% | 1.3% | 1.2% | 0.7% |
| Germany | DTS | over 24 | 6.3% | 5.0% | 7.1% | 8.5% |
| Denmark | DTS | 12-24 | 19.0% | 17.9% | 12.2% | 11.5% |
| Denmark | PGP | 00-12 | 14.3% | 12.4% | 6.1% | 3.4% |
| Denmark | PGP | 12-24 | 8.0% | 5.6% | 7.1% | 6.7% |
| Denmark | PMP | 00-12 | 2.9% | 3.0% | 1.1% | 0.6% |
| Denmark | PMP | 12-24 | 5.5% | 6.5% | 4.8% | 3.7% |
| Denmark | PTS | 24-40 | 4.2% | 5.6% | 6.7% | 6.2% |
| France | DTS | 12-24 | 0.4% | 0.5% | 0.0% | 3.6% |
| France | DTS | 24-40 | 0.3% | 0.5% | 0.0% | 2.2% |
| UK | DFN | 12-24 | 0.4% | 0.2% | 1.3% | 1.3% |
| UK | DTS | 12-24 | 7.1% | 9.3% | 14.3% | 13.6% |
| UK | DTS | 24-40 | 12.1% | 12.9% | 19.6% | 18.5% |
| UK | DTS | over 40 | 0.4% | 0.3% | 1.8% | 1.4% |
| Netherlands | DTS | 24-40 | 0.2% | 0.4% | 1.2% | 1.3% |
| Netherlands | TBB | 12-24 | 0.6% | 0.5% | 1.4% | 0.0% |
| Netherlands | TBB | 24-40 | 0.4% | 0.4% | 0.8% | 0.9% |
| Netherlands | TBB | over 40 | 1.8% | 2.1% | 3.2% | 3.4% |

Table: Selected fleets, employment (FTE)

| Member State | | Vessel Length (m) | 2006 | 2007 | 2008 | 2009 | % change 2006-9 |
|---|---|---|---|---|---|---|---|
| Belgium | TBB | 24-40 | NA | NA | 245 | 210 | NA |
| Germany | DTS | 12-24 | 161 | 149 | 107 | 96 | -40% |
| Germany | DTS | over 24 | 279 | 279 | 191 | 232 | -17% |
| Denmark | DTS | 12-24 | 544 | 383 | 552 | 495 | -9% |
| Denmark | PGP | 00-12 | 400 | 276 | 113* | 115* | -71% |
| Denmark | PGP | 12-24 | 286 | 159 | 109 | 84 | -71% |
| Denmark | PMP | 00-12 | 64 | 64 | 23* | 21* | -67% |
| Denmark | PMP | 12-24 | 140 | 111 | 129 | 107 | -23% |
| Denmark | PTS | 24-40 | 452 | 296 | 248 | 260 | -42% |
| France | DTS | 12-24 | 2309 | 2209 | 1463 | 1398 | -39% |
| France | DTS | 24-40 | 657 | 641 | 453 | 585 | -11% |
| UK | DFN | 12-24 | NA | 81 | 58 | 61 | NA |
| UK | DTS | 12-24 | 1970 | 1947 | 2394 | 2037 | 3% |
| UK | DTS | 24-40 | 769 | 769 | 715 | 765 | -1% |
| UK | DTS | over 40 | 203 | 165 | 128 | 123 | -40% |
| Netherlands | DTS | 24-40 | 66 | 74 | 101 | 99 | 51% |
| Netherlands | TBB | 12-24 | 498 | 503 | 505 | 505* | 1% |
| Netherlands | TBB | 24-40 | 203 | 194 | 155 | 177 | -13% |
| Netherlands | TBB | over 40 | 525 | 522 | 454 | 392 | -25% |

*estimated values

Table: Selected fleets, number of vessels

| Member State | | Vessel Length (m) | 2006 | 2007 | 2008 | 2009 | % change 2006-9 |
|---|---|---|---|---|---|---|---|
| Belgium | TBB | 24-40 | 53 | 51 | 47 | 40 | -25% |
| Germany | DTS | 12-24 | 75 | 77 | 72 | 67 | -11% |
| Germany | DTS | over 24 | 25 | 20 | 24 | 24 | -4% |
| Denmark | DTS | 12-24 | 271 | 211 | 263 | 254 | -6% |
| Denmark | PGP | 00-12 | 1225 | 1153 | 363 | 368 | -70% |
| Denmark | PGP | 12-24 | 118 | 81 | 59 | 59 | -50% |
| Denmark | PMP | 00-12 | 122 | 127 | 48 | 43 | -65% |
| Denmark | PMP | 12-24 | 76 | 64 | 63 | 61 | -20% |
| Denmark | PTS | 24-40 | 86 | 67 | 51 | 46 | -47% |
| France | DTS | 12-24 | 493 | 484 | 460 | 396 | -20% |
| France | DTS | 24-40 | 117 | 116 | 107 | 95 | -19% |
| UK | DFN | 12-24 | 23 | 21 | 22 | 18 | -22% |
| UK | DTS | 12-24 | 495 | 492 | 509 | 491 | -1% |
| UK | DTS | 24-40 | 107 | 106 | 108 | 106 | -1% |
| UK | DTS | over 40 | 11 | 10 | 14 | 11 | 0% |
| Netherlands | DTS | 24-40 | 14 | 15 | 19 | 24 | 71% |
| Netherlands | TBB | 12-24 | 197 | 188 | 182 | 183 | -7% |
| Netherlands | TBB | 24-40 | 51 | 42 | 40 | 31 | -39% |
| Netherlands | TBB | over 40 | 100 | 84 | 84 | 64 | -36% |

Table: Selected fleets, total operating costs (EUR m)** (sum of fuel, crew, variable and repair costs)

| Member State | | Vessel Length (m) | 2006 | 2007 | 2008 | 2009 | % change 2006-9 |
|---|---|---|---|---|---|---|---|
| Belgium | TBB | 24-40 | 75.38 | 61.18 | 52.85 | 39.29 | -48% |
| Germany | DTS | 12-24 | 13.24 | 13.13 | 9.14 | 8.10 | -39% |
| Germany | DTS | over 24 | 23.16 | 27.32 | 49.14 | 42.44 | 83% |
| Denmark | DTS | 12-24 | 50.75 | 42.49 | 56.27 | 46.71 | -8% |
| Denmark | PGP | 00-12 | 30.64 | 24.28 | 10.43 | 8.93 | -71% |
| Denmark | PGP | 12-24 | 23.85 | 14.58 | 7.71 | 6.42 | -73% |
| Denmark | PMP | 00-12 | 5.17 | 6.62 | 3.86 | 3.13 | -39% |
| Denmark | PMP | 12-24 | 15.49 | 13.73 | 13.21 | 9.80 | -37% |
| Denmark | PTS | 24-40 | 60.41 | 43.73 | 39.10 | 34.01 | -44% |
| France | DTS | 12-24 | 244.82 | 245.97 | 175.16 | 158.03 | -35% |
| France | DTS | 24-40 | 76.41 | 79.38 | 65.45 | 66.03 | -14% |
| UK | DFN | 12-24 | 4.44 | 1.42 | 3.74 | 3.49 | -21% |
| UK | DTS | 12-24 | 148.99 | 176.10 | 125.60 | 109.28 | -27% |
| UK | DTS | 24-40 | 102.99 | 99.37 | 86.60 | 85.37 | -17% |
| UK | DTS | over 40 | 24.07 | 26.07 | 24.31 | 24.17 | 0% |
| Netherlands | DTS | 24-40 | 6.86 | 9.27 | 14.67 | 10.74 | 57% |
| Netherlands | TBB | 12-24 | 42.16 | 42.63 | 45.92 | 2.34 | -94% |
| Netherlands | TBB | 24-40 | 33.73 | 32.60 | 29.35 | 21.69 | -36% |
| Netherlands | TBB | over 40 | 99.37 | 101.71 | 94.47 | 68.17 | -31% |

**Included for illustrative purposes

Table: Selected fleets, value of all landings (EUR m)

| Member State | | Vessel Length (m) | 2006 | 2007 | 2008 | 2009 | % change 2006-9 |
|---|---|---|---|---|---|---|---|
| Belgium | TBB | 24-40 | 22.69 | 20.20 | 39.59 | 32.72 | 44% |
| Germany | DTS | 12-24 | 10.62 | 11.16 | 9.71 | 5.35 | -50% |
| Germany | DTS | over 24 | 22.91 | 20.45 | 19.50 | 21.34 | -7% |
| Denmark | DTS | 12-24 | 62.38 | 55.72 | 64.02 | 57.70 | -8% |
| Denmark | PGP | 00-12 | 30.84 | 27.57 | 11.60 | 9.31 | -70% |
| Denmark | PGP | 12-24 | 27.20 | 18.42 | 16.10 | 14.89 | -45% |
| Denmark | PMP | 00-12 | 6.34 | 6.64 | 3.45 | 2.52 | -60% |
| Denmark | PMP | 12-24 | 19.92 | 19.90 | 13.14 | 10.19 | -49% |
| Denmark | PTS | 24-40 | 81.36 | 58.74 | 50.24 | 46.35 | -43% |
| France | DTS | 12-24 | 5.11 | 6.36 | 0.00 | 30.71 | 501% |
| France | DTS | 24-40 | 3.55 | 4.60 | 0.00 | 25.26 | 612% |
| UK | DFN | 12-24 | 0.49 | 0.29 | 0.83 | 0.93 | 89% |
| UK | DTS | 12-24 | 121.22 | 137.28 | 171.73 | 134.24 | 11% |
| UK | DTS | 24-40 | 83.96 | 91.08 | 92.93 | 82.32 | -2% |
| UK | DTS | over 40 | 5.46 | 5.29 | 13.72 | 12.58 | 131% |
| Netherlands | DTS | 24-40 | 6.33 | 9.97 | 21.71 | 15.51 | 145% |
| Netherlands | TBB | 12-24 | 46.79 | 62.13 | 61.19 | 2.50 | -95% |
| Netherlands | TBB | 24-40 | 35.41 | 36.01 | 27.04 | 25.88 | -27% |
| Netherlands | TBB | over 40 | 137.09 | 137.66 | 114.30 | 109.65 | -20% |

FISHING_TECHNIQUE (Gear Codes)

| | | |
|---|---|---|
| DFN | = | Drift and/or fixed netters |
| DRB | = | Dredgers |
| DTS | = | Demersal trawlers and/or demersal seiners |
| FPO | = | Vessels using pots and/or traps |
| HOK | = | Vessels using hooks |
| MGO | = | Vessel using other active gears |
| MGP | = | Vessels using polyvalent active gears only |
| PG | = | Vessels using passive gears only for vessels < 12m |
| PGO | = | Vessels using other passive gears |
| PGP | = | Vessels using polyvalent passive gears only |
| PMP | = | Vessels using active and passive gears |
| PS | = | Purse seiners |
| TM | = | Pelagic trawlers |
| TBB | = | Beam trawlers |

https://datacollection.jrc.ec.europa.eu/web/dcf/wordef/fleet-segment-dcf

## ANNEX 16 Evaluation of TACs, Effort under No Plan option

**Objective:** to evaluate the consequences of not having the 2008 agreed plan for four cod stocks in Kattegat, North Sea, West of Scotland and Irish Sea.

**Principles :** If there is no plan from 2008 onwards it is assume that the advice and proposals for TAC and effort would follow the approach laid out in the annual policy documents from the Commission. The relevant clauses from the three years 2008 to 2010 referring to TACs to be set in 2009 to 2011 are tabulated (Table 1). This table indicates the with an asterix the clause that would apply by year for each stock. In general the North Sea stock is expected to follow the clause based on a 'know state of the stock' and the stock being evaluated as 'outside safe biological limits'. For the three other stocks no assessment was available for most years so it is assumed that STECF would follow the general ICES advice for 'zero catch', and that the state of the stock would be defined as 'unknown'.

The change in applied rules result in possibility of changes in Effort (kWattdays at sea) and allowed landings through changes in TAC. These changes might also result in different catches which would potentially affect the state of the stock.

**Outcome TACs and Effort:** The TACs set under the plan regulation, the new TACs set under the policy document if there was no plan are given in Table 2. For conditions under the plan we note effort changes as % change at the headline rate without considering derogations or any other differences among fleets. For the 'no plan' option we have applied the clauses in Table 1 following the asterisks in the right hand columns. For TACs the results are fairly clear. Thus the tonnages of legal landings under the plan and under 'no plan' are give in columns 3 and 7 respectively. Column 10 gives the change in landings expressed at a ±% of the TAC originally set under the plan. For economic considerations of potential income the 'no plan' option landings and replace the landings under the plan. This is likely to be the case for 'national' allocations but may not be the case for individual fleets. Its difficult to predict income on a fleet basis as what would happen may be different as fishermen may change strategy gears etc. in response the changes in landings. However, in the absence of any alternative information for individual fleets the ratio of 'no plan' to plan landings could be applied provided vessels quota remains within the same segments.

For Effort the no plan option is likely to have been less restrictive. Column 8 gives an indication of the Commission policy in the absence of the plan. For NS cod no effort restrictions would have applied, this might have a number of consequences consequences.

- Effort restrictions could have remained the same or been removed.
- Vessel costs might have changed as vessels fished for longer but might have used slower speeds, or reacted in a variety of ways to the greater effort allowed
- If there were fishing opportunities on other species (untaken TACs) these might have been taken.

For the other stocks the would have been an explicit requirement to reduce Effort but the amount was not specified. Possibly resulting in a similar though potentially smaller effect along the same lines as NS cod.

**Outcome catches and stock:** It is more difficult to estimate what might have happened to catch; there are several considerations as follows

1. Do the TACs constrain the catch 2009-2010,

    - The ratio of 'removals' to TAC is available for North Sea, West of Scotland and Irish Sea. (see table) However, the basis for 'removals' is different among stocks.

    - For North Sea and West of Scotland this ratio seems to support an assertion that the TACs are not controlling catch.

    - For the Irish Sea TACs may be controlling catch. However, for Irish Sea 'no plan' has the same TAC as 'plan' so there is no change in the plan/no plan TAC on catch.

    - For Kattegat there is no estimate of removals so the consequences are not estimable.

Overall for these diverse reasons we conclude that there is no measurable influence of the TACs set under plan/no plan on catches. It is considered that in this context 2011 may be different, particularly for the Kattegat with a more dramatic change in TAC.

2. Have effort changes had an impact on catch.

    - For Kattegat we have no estimate of removals so it is not possible to estimate catch or change in catch between no plan / plan

    - For Kattegat, West of Scotland and Irish Sea the 'no plan' regulation specifies a TAC reduction explicitly but refers to effort reduction (Table 1) but without giving any indication of the magnitude of the value for the scale of the change in effort. For these stocks we have decided we have no basis to determine what the effort change would be under 'no plan' and even if there was a change what this change would have done to altered the catch.

    - For NS the situation is complex. For 2008 and 2009 under the plan the ratio of removals to TAC decreases slightly as headline effort declines under the plan (Table 1). Under 'no plan' there would have been no effort reduction. Its unknown what would have happened to catch but as removals were at 2.6 times the TAC it does not seem to be convincing that the headline effort rate is strongly controlling catch. For 2010 the ratio of removals to TAC is not know yet.

    - For NS it is possible that 'no plan' would have resulted in higher F in 2009/2010 but not in a direction to change the state of the stock from 'below Blim' and probably not enough to change average catch over the two years by much. Thus the state of the stock might have been worse but is unlikely to be better even though TACs would have been smaller.

**Conclusions**

Table 2 gives the values for legal landings by stock under 'plan' and 'no plan' that could be used in economic study. The differences between Plan / No plan are all small (--10%) except for Kattegat in 2011. With the exception of the Kattegat in 2011 TACs have been higher under the plan than would have been the case following the EC policy document.

While for catches, its fairly clear that changing TACs from plan to 'no plan' does not imply quantifiable changes in the catch, it is not clear if changes in effort control would have changed catches. 'No plan' would have resulted in no reduction in effort in the North Sea so the result would have been higher effort. Although the No plan option for other areas specifies reduction in effort but without a specified magnitude, it seems most likely that there would have been higher effort in all areas.

Conclusions for outcomes are weak, however, overall the difference between no plan and plan would have been in general similar or lower TACs and similar or greater fishing effort, which would be most likely to have resulted in lower income, possibly higher costs, and possibly higher F and lower SSB, though all this differences would have been small.

**Table 1 The Commission annual policy advice by year that is relevant for cod stocks. * indicates that the line of policy advice that fits the state of stock and data situation.**

| Year | Status | Rule | Reduction | K | NS | WS | IS |
|---|---|---|---|---|---|---|---|
| 2008 for 2009 | Stock outside safe biological limits | Aim to set the TAC to the forecast catch that will result in a 30% reduction in fishing mortality rate, **but** do not decrease the fishing mortality so far as to prejudice long-term yields * **and** do not reduce the TAC by more than 20%. * As measured by the fishing mortality corresponding to a marginal yield of 10% of the marginal yield at fishing mortality close to zero (F0.1). | 20% | | * | | |
| | STECF advises a zero catch, a reduction to the lowest possible level or similar advice. | The TAC should be reduced by at least 25%. Recovery measures should be implemented including effort reductions and introduction of more selective fishing gear. | 25% | * | | * | * |
| 2009 for 2010 | Stock outside safe biological limits | Aim to set the TAC to the forecast catch that will result in a 30% reduction in fishing mortality rate, **but** do not reduce the TAC by more than 20% as long as fishing mortality will not increase. | 20%? | | * | | |
| | STECF advises a zero catch, a reduction to the lowest possible level or similar advice. | The TAC should be reduced by at least 25%. Recovery measures should be implemented including effort reductions and introduction of more selective fishing gear. | 25% | * | | * | * |
| 2010 for 2011 | Stock outside safe biological limits | Aim to set the TAC to the highest value of (a) the forecast catch corresponding to taking the highest yield in the long term,or (b) the catch corresponding to reducing the fishing mortality rate by the larger value of (i) 30% (ii) one quarter of the difference between the current fishing mortality and the rate that would provide the highest yield in the long term but do not reduce the TAC by more than 30% as long as fishing mortality will not increase. | F 30% | | * | | |
| | STECF advises a zero catch, a reduction to the lowest possible level or similar advice. | The TAC should be reduced by at least 25%. Recovery measures should be implemented including effort reductions and introduction of more selective fishing gear. | 25% | * | | * | * |

**Table 2 Comparison of TAC and nominal effort changes under the 2008 plan and the TACs and changes in effort under 'No plan', see text for details of assumptions. The changes are summarized as the ratio of (no plan/plan) landings Also included is a column that indicates what we conclude might change in catch and a comment concerning the basis for the TACs set where this is not obvious.**

| Stock | Year | Under Plan | | | Under no plan | | | Realized Fishery | No Plan/ Plan | | Comment on outcome or basis of plan |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Applied TAC | %change from previous year | Effort Reduction Approx# | %change from previous year | TAC (max) | Effort Reduction | Ratio Removals /TAC | % change in allowed landings | Effect on catch | |
| Kattegat | 2008 | 673 | | | | | | Unknown | | | |
| | 2009 | 505 | -25% | -25% | -25% | 505 | reduction unknown | Unknown | No difference | Unquantifiable | |
| | 2010 | 379 | -25% | -25% | -25% | 379 | reduction unknown | Unknown | No difference | Unquantifiable | |
| | 2011 | 190 | -50% | ?? | -25% | 284 | reduction unknown | Unknown | 50% increase | | Basis of 50% unknown |
| West of Scotland | 2008 | 402 | | | | | | 11.5 | | | |
| | 2009 | 302 | -25% | -25% | -25% | 302 | reduction unknown | 14.9 | No difference | Unquantifiable | |
| | 2010 | 240 | -21% | -21% | -25% | 227 | reduction unknown | | 6% reduction | Unquantifiable | 25% plan reduced to 21% change |
| | 2011 | 182 | -24% | -24% | -25% | 170 | reduction unknown | | 7% reduction | | 25% plan reduced to 24% change |
| Irish Sea | 2008 | 1199 | | | | | | 1.5 | | | |
| | 2009 | 899 | -25% | -25% | -25% | 899 | reduction unknown | 1.2 | No difference | Unquantifiable | |
| | 2010 | 674 | -25% | -25% | -25% | 674 | reduction unknown | | No difference | Unquantifiable | |
| | 2011 | 506 | -25% | -25% | -25% | 506 | reduction unknown | | No difference | | |
| North Sea | 2008 | 25290 | | | | | | 3.3 | | | |
| | 2009 | 34590 | +37%* | -25% | +35% | 34015 | No effort change | 2.6 | No difference | Unquantifiable | 30% reduction in F |
| | 2010 | 40300 | +17% | -10% | +5% | 36320 | No effort change | | 10% reduction | Unquantifiable | 30% reduction in F |
| | 2011 | 32241 | -20% | -10% | -20% | 29056 | No effort change | | 10%reduction | | 20% reduction in TAC |

**TAC uncertain due to unknown way of allocation of VIId part of NS stock TAC from combined TAC IIVb-k TAC , # effort reduction is headline effort not taking into account any exemptions under articles.**

## Annex 17 Cod Recovery Plan: Survey of Fishing Vessel Owners and Operators: Final Report 21 July 2011

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### 1. Introduction to the report

This report describes the results from a small survey of fishing vessel operators and owners undertaken in June 2011. The survey was undertaken in a short time frame using on-line questionnaires and telephone interviews. Respondents are mainly operators from the UK and France, but there are also submissions from two owners of multiple vessels.

The work was undertaken for provide input to the Expert working group evaluation of multi-annual plans for Cod in the Irish Sea, Kattegat, North Sea, and West of Scotland being undertaken for the Scientific, Technical and Economic Committee for Fisheries (STECF) in June 2011.

### 2. Aims of the Survey

There were four areas of exploration for the survey:

- Describe effects of the Cod Recovery Plan on different fleet sectors
- Identify specific measures of the plan that concern each vessel
- Identify consequences of the Plan for each vessel and the business decisions being taken by vessel operator
- Explore what is expected to happen for the vessel/operator if the Plan does not change

A questionnaire was designed to explore the relevant areas of interest. The questionnaire was developed for telephone and on-line delivery.

### 3. Sample Description

Fishing vessels were selected for sample inclusion by key stakeholders in each Member State to provide a representative group of fishers using different gear in the areas covered by the Cod Recovery Plan. Those sampled are thus not a random sample of fleets, but aimed at being ‘representative’ of current fishing effort.

Vessel owners/operators were given the option of answering the questionnaire either on-line or through a phone conversation. There were a total of 17 respondents. Of these: 9 responses were received through the on-line questionnaire (5 complete and 4 partially completed, 6 UK and 3 French) and 8 through telephone interviews. There were also 2 e-mailed submissions (although not all questions were answered, 1 UK and 1 French).

Fishing vessels in the survey identified the following as their main port of operation:

Peterhead (7)
Fleetwood
North Bay, Barra
Scrabster
Fraserburgh (2)
North Shields
Lerwick
Scarborough
Lossiemouth
Boulogne (7 vessels belonging to one organisation and 3 others)
Harlinglen
Kilkeel

**Fishing Areas**

The table below illustrates areas in which vessels are operating. The majority of those in the sample were operating in the North Sea with smaller numbers in the West of Scotland, Eastern Channel (French vessels out of Boulogne), Faroes and other areas. The North Sea numbers are inflated by one respondent operating 7 trawlers, five of which were targeting Saithe in the North Sea (and three of these five were also targeting Cod). Numbers in the table below indicate number of vessels rather than number of survey respondents (some respondents operate multiple vessels).

| | |
|---|---|
| North Sea | 19 |
| Skagerrak | |
| Eastern Channel | 4 |
| Kattegat | |
| West of Scotland | 7 |
| Irish Sea | 2 |
| Faroe | 3 |
| Moray Firth | 1 |

## 4. Analysis of Data

### Method of Fishing

Methods of fishing varied and most vessels were using more than one type of gear depending on the fish species being targeted. Table 1 below indicates that the majority of respondents are demersal trawlers.

Table 2 identifies the main types of species targeted by respondents. The majority of vessels are targeting multiple species, for example Cod, Haddock and Whiting, or Saithe and Cod. One or two vessels have a wider range of species but only appear to catch small amounts of each. Cod, Haddock, Whiting and Saithe are the main target species with 10 boats targeting Cod. Only limited information was available regarding main sources of income and no real conclusions can be drawn. There was some indication that several respondents had altered their target species and many fewer were now targeting Cod, with resultant reduction in the significance of Cod as a source of income.

**Table 1. Type of Gear**

| Main type of gear | Comments |
|---|---|
| Beam Trawl > =80mm | 1 Twin rig (in combination with 120mm)<br>1 twin rig 120mm<br>1 >=80mm |
| Demersal trawl >=100mm | 9<br>2 (100mm and 70-99mm)<br>7 (same organisation – using 110mm and 120mm) |
| Demersal trawl >=70-99mm | 2 |
| Seine net | 2 |

**Table 2. Target Species**

| Species | Tick if yes | Main income species & approx % | Species | Tick if yes | Main income species & approx % |
|---|---|---|---|---|---|
| Cod | 11 | 1 vessel 60-65% from Cod, Haddock, whiting | Lemon sole | 1 | Small amounts |
| Haddock | 8 | | Pollack | 1 | Small amounts |
| Whiting | 7 | 1 vessel 50% and 25% from Nephrops | Turbot | 1 | |
| Saithe | 8 | 5 vessels from same organisation targeting Saithe | Plaice | 2<br><br>1 | Small amounts<br><br>Summer target species 75% |
| Monkfish | 4 | | Halibut | | |
| Herring | 1 | | Deep sea: Blue Ling, black scabbard, Grenadier | 1 | 2 vessels from same organisation targeting deep sea species |
| Nephrops | 4 | 1vessel 75%<br>1 vessel 90% | Megrim | 1 | |
| Scallops | | | Mackerel | 1 | |
| Prawn | 1 | 90% | Dover sole | 1 | Winter target species |

### Crew size

Crew sizes tend to be small (less than 10) and in most cases crew size has altered over the past 3 – 5 years. In several cases crew size had been reduced by one person (full time or seasonally, usually to save money), but sometimes more significantly, for example:

- One vessel reported a crew of six, down from 10 working non-stop on a rotational basis.

- One vessel reported reducing from 5 to 3 as quotas have dropped to make it economic
- One vessel reported a crew size of 14 with no changes.
- One vessel reported increasing crew size by one as the crew was now from the Philippinnes and Indonesia rather than Scotland.
- One vessel reported increasing crew size by 2 (from 5 to 7)
- One vessel switched from white fish to Prawns and now takes on more crew in summer

## 5. Impact of the Cod Recovery Plan (since 1 January 2009) on operation of vessels

Key changes have been an increase in days spent in port and changes in species targeted. Nine respondents indicated they had switched target species to avoid Cod. A large proportion of vessels reported switching from Cod to other target species including Whiting, Haddock and Nephrops. These respondents also indicated a key strategy has been to change the areas in which they fish to avoid catching Cod. Vessels report having to be more careful where they go, how far they go, and which days they go to sea in order to maximise revenue from fishing voyages. It was clear from respondents that vessels spend more time in port and that fishing effort has been reduced in terms of number of days spent at sea. An associated result has been changes in fishing patterns and greater consideration of when and where a vessel will go fishing.

Fewer vessels had switched gear, only six vessels reported changing gear as a result of the plan and only three respondents indicated any investment in new equipment as a result of the Plan. For many fishermen, as revealed in later questions, the plan has created business uncertainties, which has decreased investments. Some gear changes have occurred but this appear to be limited (e.g. moving to smaller mesh size) and respondents indicated that gear changes were limited in effectiveness. The most common means of reducing Cod catch were to try and avoid areas where Cod were known to exist in abundance.

Only one respondent indicated diversification into other activities to maintain income levels (e.g. offshore installation guard duties), although there were comments from other respondents that crew members were seeking work elsewhere, and the offshore oil industry provides an option for a more secure income stream.

Respondents were asked about the effectiveness of their Cod avoidance measures. This was difficult for them to determine as the majority were trying to avoid Cod by not fishing in areas where they know they will usually find this species. Those in the southern part of the North Sea and Eastern Channel were finding it easier as the perception among respondents is that there are fewer Cod to be found there. Those fishing in the Northern North Sea and west of Scotland appear to be finding it more difficult to avoid cod even though they actively try to stay out of known Cod areas.

The majority of respondents indicated they were actively avoiding Cod in some manner, usually by ensuring they did not fish in zone where they knew Cod could be found, or through leaving areas when it was clear that they were catching too many Cod even though targeting other species. Table 4 summarises some of the comments regarding perceived effectiveness of the some of the measures being taken.

**Table 3. Changes in activity as a result of the Cod Recovery Plan**

| Changes in activity | Number of Vessels | Comments |
|---|---|---|
| Switch gear | 6 | Moved to TR2 smaller mesh size<br>Moved to Orkney trawl with larger cod end mesh size |
| Switch target species | 11 | Considered other species such as squid.<br>Whiting now, we used to do Cod and Nephrops<br>'We cannot target Cod – we avoid it.'<br>'Now less targeting of Monkfish because change in nets.'<br>'had to diversify to utilise more species'<br>'Changed fishing patterns over a long period to switch away from whitefish'<br>'Target more Haddock'<br>'made us fish more on the west coast outside the Cod Recovery Zone' |
| Invest in new gear | 3 | 'No – we modify existing gear'<br>'Not in an economic position to switch gear – we repair rather than buy new gear.' |
| Spend more time in port | 11 | 'Sea time reduced from 200 days down to 125.'<br>'Reduced to 180 days'<br>'Slightly more'<br>'a lot more'<br>'Tremendously' |
| Other changes | 7 | 'More selective on how far we go and which days we go to sea, we don't go as far.'<br>'Vessels doing guard work on offshore installations – diversifying to find other income.'<br>'We have relocated due to cod, haddock and whiting allowance – seek out places where there are fewer of these fish.'<br>'Changing fishing zones to avoid areas the Cod are in.'<br>Don't come back to Hull because of changed fishing pattern and we buy days at sea from others.'<br>'Trip length has increased as we have to go further.'<br>'Had to leave areas where prawn catch was productive to avoid catching cod.'<br>'Fuel for fishing – costs more as we go further, and leasing, we buy in days and quota, (about £6,000/yr)' |

In terms of effectiveness – those fishermen that indicated they had changed mesh size reported limited utility of this measure. The comments regarding nets suggest that fishermen find changes to mesh size to be of limited effectiveness and integrate any change with more active avoidance measures, such as trying to stay out of areas where they think there will be large numbers of Cod.

Only one respondent indicated that additional avoidance measures were being considered, and that was to stay out of areas where Cod was known to exist. The majority of respondents were already taking what they considered to be the most effective Cod avoidance action, and did not seem able to consider further action. Part of the issue here may be that fishermen perceive the reduction in effort also to be a Cod avoidance measure. So although they indicate diversifying into other species, and trying to avoid areas of Cod abundance, it does not stop Cod being caught as the focus of fishermen is ensuring a profitable trip based on their target species. If that results in excessive by-catch and discarding of Cod then the view of respondents is that the fault lies with the Recovery Plan and the limits on Cod quota which prevent them from landing the Cod that is caught. There is insufficient data from the survey to draw any conclusions on whether ‘sufficient’ avoidance action is being taken, but the impression given by fishermen is that they are doing everything they can, within the financial constraints of their businesses. More avoidance measures mean higher costs (e.g. new nets, higher fuel costs, higher wages) which inevitably are not looked on favourably. Current actions, in particular avoiding areas of Cod abundance, are necessary as catching Cod imposes a cost to vessels. Catching more Cod means that more time and effort is required to obtain the target species, and discard the unwanted species. Catching Cod imposes costs on vessel operations, and avoiding Cod also imposes costs (e.g. more fuel, lower levels of target species); the vessel operator needs to balance the costs and select the cheapest option – sometimes this will mean fishing in areas of cod abundance which may account to the high levels of discards still being reported.

12 of 17 respondents indicated they discard Cod and 9 indicate discarding of other species. The issue of discards is not related solely to Cod but with Cod the impression given by responses to the questions on discarding suggest that a significant amount of high grading is occurring. Vessels are landing the best fish, which increase the value of any particular fishing trip. Discarding is not solely related to meeting quota allocations and catch composition rules, but also to maximising the return on each individual fishing trip. It is not clear from the data in the survey how much of the discarding is the result of exceeding catch-composition rules, and how much is due to high-grading.

Respondents were also asked to suggest other possible measures that might work better. There were few responses to this question, and most fishermen did not have any suggestions for change. One respondent indicated that increasing mesh size would result in losses of smaller targeted fish. Respondents from France indicated that rules needed to be more flexible and should not be applied uniformly across all fleets. Vessels need flexibility to be able to switch gear and adapt to relative abundance of species that are found.

*“It is necessary to think about the fishing activity rather than to have the same measures for all. The closures in real time are not adapted to small boats with limited areas of activity. They should think more in terms of productivity of each fishing journey and the value of the fish species that were caught.” (French vessel operator)*

**Table 4. Adoption of Cod avoidance measures**

| Type of action | Effectiveness |
|---|---|
| Square mesh panels (120mm) | 'No noticeable difference in what we were catching.'<br><br>'No matter what the fisherman does it does not make much difference – we are doing all the conservation measures we can.' |
| New nets. This is for all fish not just Cod – we are experimenting with nets that do not catch the higher swimming fish. | I think it is – we need height in the net to catch Cod, but also been actively avoiding areas where we find Cod. |
| Not targeting Cod | You still catch some but we know where they are and how to avoid them.<br>Not our target species but in winter time we catch some boxes of Cod.<br>One respondent indicated that Cod were eating prawns which he was trying to catch so it was extremely difficult to avoid catching them – 'when we clean the Cod that are caught their bellies are full of prawns.' |
| Changing zones/changing nets | I don't know if it is efficient, since we cannot take cod we have put more effort into sole.<br>No special measures but I must change every time when I am in zone with a lot of cod. It is impossible for a responsible fisherman to discard or to catch immature fish. |
| Cameras | Stay away from areas with abundance of cod. We have CCTV on board. |
| Changing fishing areas to avoid Cod | It is impossible to verify if this is efficient to preserve the Cod but I know it is not good for the company. Two issues: more time travelling, and more time at sea to find other species; too much expenditure on fuel so losses of money at the end. Problem of being with other ships because everybody now goes to the same zones. |

## 6. Financial impacts of the Cod Recovery Plan

*"We recruited cheaper labour, make virtually no investment in new equipment unless absolutely necessary, and buy as little supplies as possible, also we cost everything now, due to leasing costs of quota and low profitability we must market our catch as best as possible. The future – I don't see one at the moment. Looks like things are going to get worse before they get better yet"*

(Scottish vessel operator)

Profitability of vessels varies, for some operators the level of expenditure and revenue is about the same as previously, for others there are slight differences caused by a range of factors ranging from fish prices to undertaking needed repairs (e.g. £10 – 15,000 better off for one boat due to 'hard work'; for another boat it was 'same as previous due to need to spend money on mechanical failures'; slightly better than previous year despite fuel prices; slightly better due to Saithe prices; a lot less profitable but also partly due to fuel prices; loss of income from dumping of fish and more effort needed but no increase in expenditure; less profitable due to higher costs).

Vessels report fuel prices as having a major impact on their profitability. This has impacted some boats more than others, depending on whether they have to go further to avoid catching Cod. Fish landing value also has an impact on profitability of a boat.

Few boats reported significant expenditure as a result of the Plan. Three respondents indicated the need to buy new nets/equipment to catch species other than Cod (£5,000, £25,000, and £45,000), and some expenditure on buying extra quota (one indicated £200,000 for 2010). Many other respondents indicated they were putting more effort into repairs than investing in new equipment.

Vessel operators also reported a range of activities to deal with a more difficult financial climate. One operator reported buying two <10m boats in order to diversify into other fisheries. Another had taken on offshore guard duty to diversify income. Only one or two interviewees reported any changes in terms of taking on part-time work, or family/crew members increasing the level of work they undertake. The following additional activities were indicated by a small number of respondents:

| *Number* | *Activity* |
|---|---|
| 1 | increased effort put into crofting |
| 5 | wife increased working hours |
| 3 | some of crew taking on other casual work (e.g. oil industry) |
| 1 | crew changed from being Scottish to foreign (due to low wages and lack of security - could not retain local people as crew) |
| 1 | loss of a crew member and salaries decreased |
| 2 | loss of crew due to inability to pay sufficiently high wages (one reported losing 4 crew due to inability to pay wages and now employs East European labour) |
| 1 | possibly stop one trawler before end of year to respect effort allocation |
| 1 | Crew had to look for other work as do not go to sea for several weeks in summer |

The impact of the Cod Recovery Plan on business decisions has been more influential. Table 5 below indicates that the main impacts are in terms of recruiting and keeping crews, investing in new equipment, and planning for the future. Several vessels indicated the difficulties of recruiting crew when future incomes are so uncertain, in particular the difficulties of getting young people and locals. Interviewees also expressed concern over difficulties of planning for the future when regulations are changing all the time and there is no guarantee of whether there enterprise could be profitable in future. Several interviewees indicated they had little optimism that they would be able to remain in business under current conditions. This is resulting in a knock-on impact in terms of reducing investments in new equipment and making operators much more careful in terms of purchasing supplies.

**Table 5. Impact of the Cod Recovery Plan on business decisions**

| Impacts on business decisions | Number of Vessels | Comments |
|---|---|---|
| Recruit crew | 8 | 'Difficult to get young people into the industry due to uncertainty of income.'<br>'Much more careful in taking on new crew as unable to pay them.'<br>'Crew is all foreign now'<br>'may lose crew this year as no security of income'<br>'cannot engage as many men' |
| Invest in new equipment | 8 | 'Repair equipment rather than buy new'<br>'Reluctant to invest in new equipment because there are no guarantees for the future'<br>'Very cautious with what we buy –invest in essentials only'<br>New nets.<br>'Cannot invest, cannot afford to mend the boat, dread a breakdown'<br>'had to buy different trawls and codends, also had to alter our ground gear rig - estimated cost £45,000' |
| Buy supplies | 4 | 'shop around more to get best prices – do not just use local supplier'<br>'Cannot plan ahead, we work from year to year'<br>'Bought nets but they might not be legal for long – this will be money down the drain' |
| Sell your catch | 5 | 'We cannot retain marketable by-catch'<br>'Market in port has been reduced'<br>'My wife has decreased income from fish sales on the quay.'<br>'We set up our own fish sales to reduce costs and make the business more efficient.' |
| Think about the future | 9 | 'There will not be a business if it remains the same'<br>'No vision for the future, no notion of seasonality.'<br>'No future vision in short and medium term for the company and the crew.'<br>'Hard to plan under these conditions' |
| Planning fishing activity | 4 | 'More careful planning needed regarding Cod'<br>'We have to plan our trips by the news we get from other boats or our own experience to avoid cod and having to discard'<br>'Travel to North Sea now and buy quota fro prawns'<br>'We are fishing harder now to make the boat profitable.' |

## 7. Impact of Cod Recovery Plan regulations

Many respondents indicated that both TAC and effort regulations were affecting their activities.

*"Both TAC and effort restrictions affect us. In 2009 TAC was too low and that had the biggest impact. Starting from 2010 the absence of flexibility between different gears has been having an impact."*

In other cases they indicated either one or the other (TAC or effort restrictions) were having more impact. The TAC results in lower quota for Cod which causes fishermen to catch their quota more quickly, they then indicate they must leave zones of productive fishing where they are targeting other species because of the by-catch and the need to discard Cod. Reduced quotas are causing vessels to change their fishing patterns (where they go and when), but it is clearly still causing discards of Cod (as well as other species). It is interesting to note that the responses are similar whether fishermen are from Scotland, England or France.

Table 6 suggests that effort restrictions appear to have been more significant financially as they force boats to stay in port, reduce income and make it more difficult to recruit and retain crew who rely on a regular wage. When boats do go out they indicate they must work harder and be more productive as they have limited days at sea and catching Cod means discard rates are higher and they then have to spend longer at sea to catch their quota of other species. There are also suggestions that more risks are being taken in order to maximise productivity during the limited days at sea.

Respondents also indicated that if the plan continued unchanged the likely impacts could be severe in terms of going out of business and leaving the fishing industry. Respondents from all areas indicated that weaker businesses, or even quite established ones, might go under due to difficulties of making a profit under current regulations. Respondents indicated that the future looks bleak, there are a lot of uncertainties, and this creates stress.

Only two respondents indicated that the Recovery Plan was not significantly impacting their operations as they were not targeting Cod, or had ample quota:

*"We only have 2% Cod so we are not hugely affected by the recovery plan."*

When asked about the future impacts if the Recovery Plan stays the same the majority of respondents (13) indicated significant implications for their business. Table 7 summarises some of the comments from the questionnaires. The Plan is making it difficult for fishermen to plan for the future and to make investments due to uncertainties over changes in regulations and future restrictions. Financial implications are significant and respondents refer to difficulties of keeping crew, switching to cheaper sources of labour for crew, making less profit, loss of revenue and increasing costs.

**Table 6. Effects of TAC and effort restrictions**

| **Impact of Total Allowable Catch (TAC)** | **Impact of effort** |
|---|---|
| 'It has reduced our quota so we have to discard more Cod and other species, especially Whiting.' | 'We have had to buy in days from other vessels' |
| So much fish in the sea and so little quota pushes up leasing costs | Catching so much fish quickly we need less time at sea to get our hold full. |
| 'Had a huge effect on us, we are easily catching our quota in many species but we do not have enough days at sea to catch our full Haddock and Monkfish quotas. | 'Effort affected us the most – it has had an effect on subsidiary businesses and we now land somewhere different.' |
| 'I have left productive areas where we were dumping by-catch including Cod because it is immoral and a | 'Spending more time in port' |

| | |
|---|---|
| waste of precious resources.’ | |
| ‘The unrealistic TAC is affecting our ability to retain marketable by-catch.’ | ‘Devastated us, reduced in number of days, no money to be made.’ |
| ‘It has changed the areas where we fish.’ | ‘We cannot go out as often so profits are decreased but the crew still need to be paid regularly – makes it harder to keep a local crew.’ |
| ‘Too low TAC – we have to land 2 tonnes of other species to put one box of Cod ashore.’ | ‘We have to put in more time because of the discard rates – and we have to go further afield.’ |
| ‘Quotas have had the biggest effect because the stocks are recovering and it is really easy for us to go out and catch our Cod quota.’ | ‘We are now more frightened by the days at sea system than TAC and quota allocation, it is difficult to know what we can do from one year to the next.’ |
| ‘Reduction of the TAC in 2009 had dramatic consequences because of the presence and abundance of large cod in the Eastern Channel and southern North Sea. This has created a reduction in income for the enterprise and a lot of misunderstanding and frustration among the crew.’ | ‘As the number of days is limited there is big pressure on the fisherman - he must become a super-fisherman in order to optimise his time at sea. He must take more risks and go out even if the weather is bad.’ |
| ‘TAC too low in 2009 and because of this there are a lot of discards which would be good in commercial terms. This means an important loss of revenue for the enterprise and the crew.’ | ‘Less quota, less effort, the enterprise will go bankrupt.’ |
| ‘The quota is too small in 2009 but the effort is not adapted to a small boat of 12 metres, there is no sense for a boat to go for one day (trips are very short and there are few trips in the year because of the weather). It is completely inadequate.’ | ‘It creates tension because it is necessary to maximise the catch each time you go out but this makes everyone tired and we use our equipment too much. We take too many security risks as we go out when the weather is bad.’ |
| | We catch less than 1% Cod but are under the days at sea regulations – this is unfair – seeing Cod in your nets used to be something positive, now you are fearful (in case you get boarded). We do everything legal but then can still be penalised. |
| ‘Needs to be more quota available and at a less high process, because of quota cuts I am sailing to North Sea to catch the quota I have bought – takes us 4 days to get there and 4 to get back.’ Last week I dumped £1,000 Cod in one week, a lot of by-catch so we have to fish harder. We are high-grading.’ | |
| it used to be effort, now it is swinging towards TACs because quota is getting so expensive to lease it’s not worth going to sea | |
| our TAC has been drastically reduced, leasing costs have rocketed, so profit has been reduced | we have to either tie the boat up or lease-in days - both cut profitability |

**Table 7. Perceived future impacts if the Cod Recovery Plan remains unchanged**

| Future impact if the Cod Recovery Plan remains unchanged |
|---|
| 'If the Cod Recovery Plan continues without major changes, we will have reduced fishing opportunities and will possibly have to leave the industry. I cannot plan with any confidence because I don't see any end to the restrictions.' |
| So much expense before my crew gets a decent wage – I may have to employ Philippino crewmen. |
| Less and less profit. |
| 'It will destroy us' |
| "I think we could manage to struggle on for a couple more years, and then we would have to give up – even though we are one of the more established businesses." |
| 'It will endanger us, each year it has bitten more deeply.' |
| 'We would probably leave the industry or go into prawns, or we might move into under-tens' |
| 'I don't want to think about that, I would get very scared.' |
| 'Major business threat – I will spend a lot more time at home.' |
| 'We must leave zones where there are fish (Sole) because of the presence of cod. Changing fishing zones for a boat of 12 metres is limited - we are limited because of size- due to health and safety, so we have difficulty in going to other zones.' |
| 'The Plan causes a decrease in income and productivity, makes it difficult to keep a crew and in finding a crew. Creates constant stress, I am developing problems with my health.' |
| 'Losses of revenue. Difficult to recruit and keep a crew that is unhappy and permanently stressed. There is a lot of stress and worry about the future. I don't know what will happen because the rules will change all the time and without any positive impact.' |
| 'It's difficult to have profits when costs are increasing. There are financial difficulties in certain periods of the year. Some enterprises, the weak businesses, will go into bankruptcy or out of the fleet.' |
| 'There is permanent stress.' |
| 'I honestly don't know what we are going to do. Our hope is that decommissioning scheme is put in place. We either need to get out or invest in new business.' |
| 'if things continue to decline at the pace they are we will probably fold or sell up' |

## 8. Views on the sustainability of Cod stocks and the role of the Cod Recovery Plan

Table 8 indicates respondent perceptions on impacts of the Recovery Plan on Cod Stocks. Respondents suggested that reduction in the number of boats through decommissioning, reducing quotas, and natural cycles all played a part in the level of Cod stocks currently being seen.

Seven respondents (around half) indicated that the Plan had helped to re-build Cod stocks – but they also suggested that decommissioning of a large number of boats prior to the plan had also had a significant impact. A larger proportion of respondents (10) indicated the parts of the Plan had damaged Cod stocks, largely through cutting quota which increased the level of discarding that is occurring. Many respondents indicated that they had discarded Cod and other species. Eight respondents also indicated that other species were being adversely affected by the Plan through increased targeting or through discarding.

Respondent suggested a variety of approaches to improving the Plan. These include increasing the quota in order to reduce the level of discards, and making the rules more flexible and more locally adaptable, even down the level of each vessel, in order to reflect the natural variability found in the sea. One suggestion was for 'set-aside' payments similar to those paid to farmers to maintain land in a productive state. Two respondents suggested improved decommissioning schemes to allow weaker businesses to exit the industry, something that is difficult to accomplish without some support. One beam trawler suggested beam trawlers should not be affected by the Recovery Plan as they were not targeting Cod.

**Table 8. Respondent perceptions of impact of the Plan on fish stocks**

| Item | Yes | No | Respondent views |
|---|---|---|---|
| Are there parts of the Cod Recovery Plan that have HELPED rebuild Cod stocks? | 7 | 3 | Decommissioning large part of the Scottish fleet<br>Decommissioning a major factor.<br>Halving the number of boats helped. But there are cycles of fish stocks, 1 month, 1 year and some are 10 year cycles.<br>Reduced effort.<br>Fewer boats because reduced quotas<br>Don't know – mixed species fishing in these areas.<br>I am not able to answer this question. But I know the cod is there in cycles and during the last cycle the cod was very important in the traditional zones of fishing. There was a lot of cod. |
| Are there parts of the Cod Recovery Plan that have DAMAGED Cod stocks? | 10 | 1 | Cutting quota has forced discards of large amounts of Cod.<br>All stocks of fish are discarded.<br>Obsession with cutting quota has led to discarding – would make more sense for us to be there half the time since if we cannot land Cod we must fish for other species.<br>Dumping female fish. There are a lot of discards<br>Yes – quota and catch composition rules have resulted in discards |
| Effect on other species | 8 | 2 | Killing immature plaice.<br>All stocks benefitted from so few boats left.<br>Discards – had to throw other species back.<br>All stock levels seem to be increasing – seeing levels not seen for 25 yrs.<br>Difficult to say – but Cod might be feeding on same as Whiting and abundance of Cod might be affecting whiting stocks.<br>More pressure on other species in order to find money to balance loss from cod to ensure profitability of company. Discards of other species to respect the percentage of the catch rules.<br>We changed our activities to Sole and there is now pressure on this species. Before, there was a season for cod, a season for sole, we are working with nature and we must have rules that are more adaptable. |
| Suggestions to improve the Cod Recovery Plan | 11 | | Make a less difficult system with a sufficient fishing effort related to the season and the target species.<br>There is a need for a link with the market. Better prices would decrease pressure on the stocks.<br>In Eastern Irish Sea there is no Cod fishery – only a seasonal one. We are forced to use small mesh to fish for |

| | | | |
|---|---|---|---|
| | | | Plaice to get more days when we don't catch any Cod at all – we get more days fishing therefore killing juvenile Plaice stocks.<br>No need – Cod stocks have recovered. Scrap it.<br>Not enough fishing opportunities.<br>A decommissioning scheme to help fishermen leave.<br>More money on a marine equivalent of set-aside – pay to stay ashore rather than discards.<br>Plenty of Cod in Shetland. Don't think cameras help as creates an elite level of fishermen and uneven playing field. Increase quotas but cannot make it free fishing.<br>Issue each vessel with a realistic workable quota.<br>Stocks recovering and are there in abundance<br>Don't believe recovery plan needed on West Coast of Scotland.<br>Get rid of the quota – they are making men fish harder and dump fish – this is increasing. It there was decommissioning it would take 90% of the boats in this harbour because of how restrictive the industry has become. |

Table 9 illustrates the range of response when questions were asked about the effects of the Plan on discarding activity. A large proportion of respondents (12) indicated they had discarded fish as a result of the Plan. The fact the quota is so low and the fish abundant seems to create real problems for fishermen and lead to an increase in discarding. Low quota is leading to some discarding as a result of high grading as well as simply staying within quota. In some cases other species are also being discarded (over half of respondents indicated this was an issue), Hake, Haddock and Whiting were mentioned in particular. Increasing the quota was seen as the only viable option by many of the respondents in order to reduce discarding.

**Table 9. Respondent actions in relation to discards**

| Actions in relation to discarding | Yes | No | Comment |
|---|---|---|---|
| Have the measures under the Cod Recovery Plan led you to discard Cod? | 14 | 2 | 'If Cod quota is so tight you have to maximise your return, we only keep large cod and discard all small.'<br>'Yes, have done in past with high grading'<br>'Quotas so low – so only keeping the best fish'<br>'Too restrictive TAC'<br>'Yes but not a lot – we don't target it – discarded 20 boxes last week and landed 110.'<br>'Catch composition rules. If we have the wrong gear and catch more we have to discard.'<br>Yes – quota is so small – we are avoiding catching cod. Last year we were discarding small and medium Cod.'<br>'Too low a quota that is not adapted to the realities at sea. 'In the past we have – but not at the moment' |
| Do the measures in the plan cause you to discard other fish? | 9 | 4 | 'Not really but we have a problem with Hake, explosion of Hake, quota has been so small and there is only a small % of TAC' so we discard some Hake – but not a |

| | | | |
|---|---|---|---|
| | | | lot’<br>‘Yes – whiting in particular’<br>‘Yes – whiting and haddock’<br>‘No – only Cod.’ |
| Do you think you should be able to land whatever you catch? | 12 | 2 | ‘Difficult to say – too much would cause market to collapse. I do believe we have to have quotas and TAC to keep fleet in line.’<br>‘Should not be allowed to land anything – plays into hands of fishermen who don’t care.’<br>‘You should be able to land the marketable stuff – in the past we have high graded due to quotas.’<br>‘Yes – we should be able to land whatever will make the boat pay.’ |
| In your view what would be the best way to reduce discarding of Cod? | ‘Increase quotas, keep boats on a tight leash as regards days, or install CCTV systems to ensure no discards, but they must receive enough quota.’<br>‘Increase quotas to a realistic level, reduce the fleet to allow boats that remain to be economically viable.’<br>‘Vessel specific TAC – each vessel to be issued with a TAC rather than entire industry, so the vessel is able to decide when it fishes, they would choose to fish then to make it more economic.’<br>‘You are going to catch Cod whether you target them or not if they are in that area.’<br>‘Issue each vessel with a realistic workable quota.’<br>‘Increase the quota – does not have to be a huge increase.’<br>‘Land what you catch.’<br>‘Get rid of quotas.’ | | |

## 9. Perception on the state of Cod stocks

In contrast to the difficulties forecast by respondents if the Plan remains unchanged, and the impact of the Plan on Cod stocks, the majority of respondents are very positive about current state of the cod stock (and stocks of other species). When asked if the Cod had increased in the areas in which they fished thirteen respondents perceived an increase in the stock (Table 10). Some respondents indicated the situation in recent years was the best that had seen for decades. Whether the improvement is caused by the Recovery Plan is less clear and respondents cite decommissioning and reduction in fleet size as being significant casual factors through creating reductions in fishing pressure.

Respondents were also asked for their views on the sustainability of Cod stocks. Eight of the respondents indicated positive responses when asked about sustainability of the stock, while none of the respondents indicated it was unsustainable. The large decrease in the number of boats was one reason suggested, and the fact that some areas are now effectively no longer fished.

Respondents were also asked whether they felt that the estimates of stocks, discards and landings were accurate. The answers were fairly consistent; most respondents felt that Cod stocks were significantly underestimated, landing data was accurate, but there was some disagreement over the accuracy of discard estimates. Some respondents felt that discards were under-estimated, some felt they were over estimated and others that they were accurate or they did not know. Perceptions of discarding seems to be influenced by the personal attitudes of the respondents who clearly feel strongly about the issue – some claim they would never discard and will leave a good fishing area to avoid discards, others clearly engage in discarding to maximise income. There is insufficient information in the survey to determine the causes for this difference of opinion on the accuracy of discard measures. Attitudes may be influenced by actions actually undertaken during fishing operations; those that engage in discarding may take the view that the level of discards are under-estimated; while those that more strenuously avoid catching cod may think that discards are over-estimated.

**Table 10. Perceptions on state of the Cod stock**

| State of the stock | No. of Vessels | Port | Comments |
|---|---|---|---|
| Increased | 15 | S, Ba, F, L, NS, Bo, P, H, K | 'Definitely seen improvement in cod stocks over last 3 yrs'<br>'They are coming back – there are few fish inshore because of the seals'<br>'The last five years it is alive with cod'<br>'Seems to be general increase. Cod disappeared in the past then turned up again 5 yrs later, part of a cycle'<br>'2009/10 massive presence of big cod in southern part of N Sea and eastern Channel'<br>'In 34 years at sea never seen as much Cod as we have now, check my log sheets.'<br>'The Cod has moved north, in southern North Sea stocks are very low, in North of North Sea stocks are high.'<br>'An increase in the last three years.' |
| Decreased | 1 | P | |
| No change | 1 | Bo | No change except in 2008/2009/2010 when there was a big presence everywhere in the zones. It is necessary to take into account cod cycle, in our waters they are here every five years cyclically.' |
| Don't know | 1 | Bo | 'Exceptional presence of cod in 2009/10 but difficult to say if anything is because of what has happened in 2009/10.' |

Note:

| | | | |
|---|---|---|---|
| S | Scrabster | Bo | Boulogne |
| Ba | Barra | F | Fraserburgh |
| L | Lerwick | NS | North Shields |
| Sc | Scarborough | P | Peterhead |
| H | Herlinglen | | |

**Table 11. Perception on accuracy of estimates**

| Respondent perceptions | Under-estimated | Over-estimated | Accurate | Comment |
|---|---|---|---|---|
| Estimates of stocks | 12 | 0 | 3 | 'It was garbage 10 yrs ago, we are dumping thousands of tonnes now.'<br>'It's a witches brew.'<br>'Seriously underestimated'<br>'Definitely under – scientists seem to be 2 yrs behind what fishermen are seeing in the sea.' |
| Estimates of discards | 4 | 4 | 5 | 'Policy makers have not got a clue'<br>'Estimates are nothing like what happens'<br>'Don't know (x2)'<br>'Overestimated – we don't discard any Cod, I would rather stay at home than throw dead fish over the side.' |
| Estimates of landings | 1 | 0 | 14 | 'Accurate – nearly spot-on.' |

### Perceptions on 'Black Fish' (illegal landing)

Respondents were asked for their views on 'black fish' (illegal landings). The overall view on 'Black fish' is that it is not taking place in any of the areas in which the respondents are based, with Cod or any other species. The majority of respondents suggested it was no longer an issue because of enforcement improvements and they would be "surprised to find it was still occurring". Others suggested that if it was occurring it was only on a very small scale. One respondent, for example, suggested that fish were eaten by the crew and small amounts might be landed as "...it is difficult to throw good fish overboard when they could be taking it home for their families." One respondent indicated it was widespread from the East Coast round Western Scotland in relation to Cod, being driven by increases in Cod and restrictive quota.

# 10. Summary

There appears to be some contradiction in the data regarding Cod avoidance measures and discarding. Vessel operators report taking avoidance measures, yet also indicate high levels of discarding. To some extent this is blamed on low quotas which mean such fish cannot be landed. There are two possible answers, either levels of Cod are higher than anticipated in areas where fishing does take place (by those vessels trying to avoid areas of high Cod abundance), or the level of avoidance activity is limited in scope.

The success of the Cod avoidance measures taken by vessels is difficult to measure given the limited amount of information collected in the survey. There is a high level of agreement that discarding of Cod (and other species) is occurring, though respondents are split on the accuracy of the measures of discards occurring. It is clear that discards occur due to high grading in order to keep within quotas which are felt to be too low, and to comply with catch composition rules. It is also clear that discarding is occurring despite vessels taking Cod avoidance measures, although again, it is difficult from the survey data to ascertain the full extent and nature of avoidance measures (for example, does cod avoidance take place on every trip, or only on selected trips?). What is clear is that vessel operators need to balance the costs of Cod avoidance (e.g. in terms of more fuel, or less favourable fishing conditions) with the costs of increased fishing effort required if high levels of Cod are caught alongside target species (e.g. longer time spent fishing, fuel and wage bills). It is this balance that determines the level of avoidance measures taken. The survey is not able to answer the question of whether the current level of avoidance activity is 'sufficient'; for vessel operators the overriding aim is financial survival within a complex set of rules. The survey suggests that few fishermen invest in new nets (as an avoidance measure), due in part to the general reluctance to invest in any new or 'un-necessary' equipment, but those that have purchased new nets with different mesh sizes as an avoidance measure report limited effectiveness in avoiding Cod. This contradiction between avoidance and discards is one area where a deeper level of research is required to fully understand the interactions between a vessel's avoidance and discarding activity.

Figures 1 and 2 below summarise the main findings from the data. In each case the larger the typeface represents similar views from a larger number of respondents. Figure 1 indicates the impacts of the Recovery Plan on respondent activities. The two key aspects are TAC and effort limits. The key factor coming out of the data is that the TAC results in low quotas which are causing higher levels of discards. The effort limits result in more time in port, changes in patterns of fishing activity, more time due to catch composition rules and discarding, and knock-on effects making it harder to keep a crew.

Figure 2 provides some views on stock levels. Respondents over-riding perception is of an abundance of Cod and healthy stock levels, in some cases levels that have not been seen for a long time. Respondents feel that Cod stocks are under-estimated and that the level of discarding is increasing because of this abundance and quotas which are set too low. There is recognition of the need for rules and quotas, but also that those rules must be more adaptable and flexible to reflect actual conditions in the natural world.

To a certain extent these perceptions must be tempered by the experience of individual respondents. In the North Sea historic fishing rates have been much higher in the past, which colours perceptions of those that have been fishing long enough to remember how it used to be, and influence perceptions of the current level of activity allowed and the level of stocks. Two of the respondents, both of whom have been fishing for more than 30 years, made reference to the similarity between today's situation and higher level of stocks from 20 – 25 years ago. Again the catch level was set higher than today which may influence perceptions regarding the level of stocks currently available. This is another area that requires deeper research in order to understand whether the perceived levels of abundance are realistic (e.g. reflecting underlying natural cycles in populations of various species (as other species are also indicated by fishermen to be present in high numbers), or whether vessel operators are misinterpreting the current population levels through comparing present observations to historically higher levels of both stocks and catch rates.

**Figure 1. Impacts of the Cod Recovery Plan**

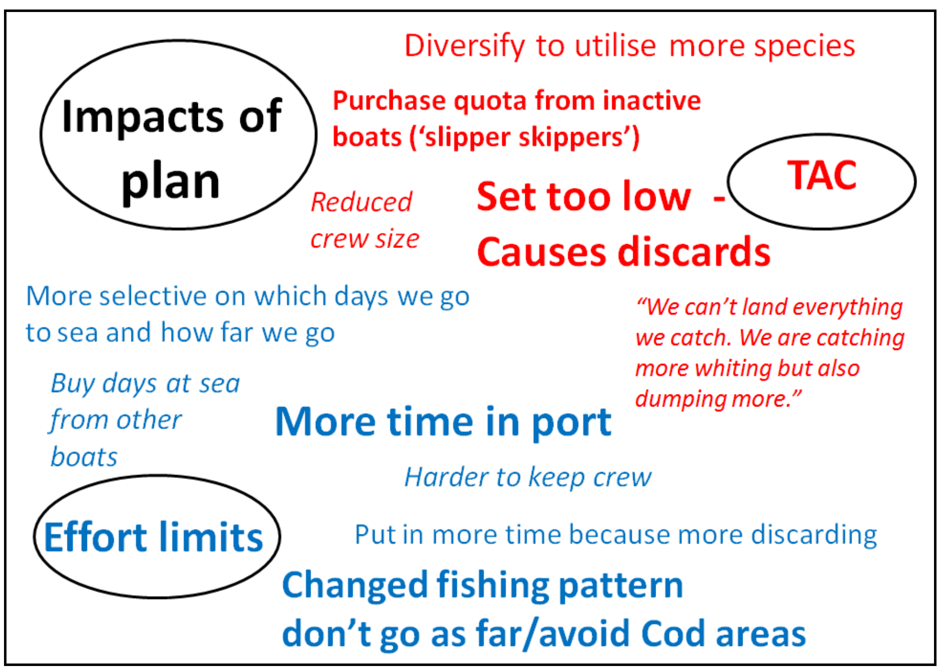
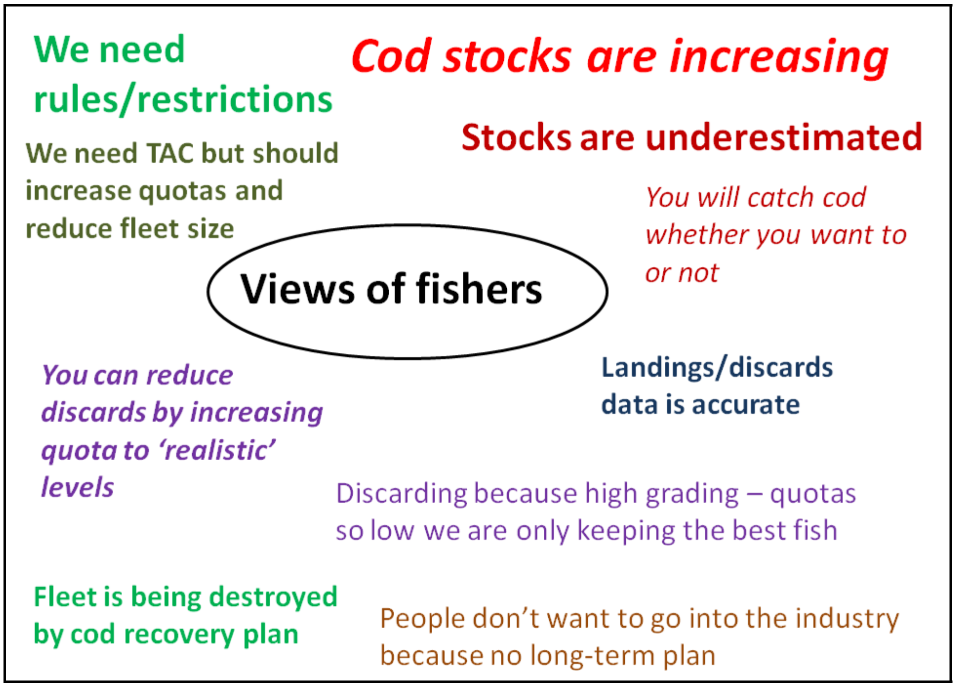


**Figure 2. Views on state of the Cod stocks**




Overall the outlook provided by a majority of the respondents is not very positive. The Cod Recovery Plan is creating financial difficulties, making it very difficult to retain a crew, plan for the future and make investments in new equipment. There is genuine concern on the part of several respondents that they will have to leave the industry and/or go out of business.

It is important to keep in mind that the data presented here represents a snapshot from a small sample of fishing vessels operating in the North Sea. It does not pretend to be a random sample (since vessels were selected to be illustrative of the level and type of activity in each area where the Cod Recovery Plan is operating), nor representative as the respondents are a self-selected group that chose to respond to the questionnaire.

The results of the survey are indicative of the views of fishermen operating under the Cod Recovery Plan. The views expressed by respondents tend to be consistent, both within each questionnaire, and across the sample, thus raising confidence in the validity of responses that have been obtained. Respondents, whether from Scotland, England or France, have similar views and perceptions.

# APPENDIX I THE TELEPHONE QUESTIONNAIRE

## Cod Management Plan Questionnaire

**Introduction**

Telephone: Hello, my name is ..........................

Or,

Email: Dear Mr. ...........

We are carrying out some research for the North Sea Regional Advisory Council (NSRAC) and would like to ask you a few questions about the current Cod Management Plan, which is coming up for review. The Countryside and Community Research Institute is an independent university based research in organisation. We will not use any of the information you give us in a way that will allow anyone to identify you, your business or your vessel, unless we explicitly ask for your permission to do so. It will take 20-30 minutes to answer the questions.

As part of the review process we have been asked to contact a number of vessel operators. These have been nominated by their representative organisations for interview about their experience of the cod management plan. (EC1342/2008)

Our aim is not to provide a comprehensive picture but to illustrate the impact of the Cod Management Plan on particular types of vessel and to explore the ways in which vessel operators have adjusted to the cod recovery measures.

Are you able to take the time now to answer some questions over the phone?

The questions are open ended to ensure that we capture all of your views.

Once completed, the interview report will be collated with others into a report that will go to the Scientists (ICES/STECF) that are charged with reviewing the Cod Plan, and ultimately to the European Commission and member states who will decide on the future of the plan.

We are mainly interested in the operation of the current plan (since January 2009 but we would also be interested to hear about any significant effects of the earlier recovery plan from January 2004 to December 2008).

### <u>First of all we would like a few details about your fishing activities:</u>

Vessel Name:

Registration Number:

Main port of operation:

Your age:

Method of Fishing:

## Gear Category (TR etc.)

| Type of gear | Tick those that apply / Comments |
|---|---|
| Beam Trawl > =80mm | |
| Demersal trawl >=100mm | |
| Demersal trawl >=70-99mm | |
| Demersal trawl >=19-31mm | |
| Longline | |
| Static | |
| Seine net | |
| Gillnet | |
| Other: | |
| Other: | |
| | |

## Target Species

- identify which species are caught (tick as many as necessary)
- identify which **ONE** species contributes to the majority of interviewee's annual income ('main income species')
- identify the APPROXIMATE % of annual income for 'main income species'

| Species | Tick if yes | Main income species? & approx % | Species | Tick if yes | Main income species? & approx % |
|---|---|---|---|---|---|
| Cod | | | Sole | | |
| Haddock | | | Lemon sole | | |
| Whiting | | | Pollack | | |
| Saithe | | | Turbot | | |
| Sole | | | Plaice | | |
| Monkfish | | | Halibut | | |
| Herring | | | Other | | |
| Nephrops | | | | | |
| Scallops | | | | | |
| Crab | | | | | |

- Has the main income species changed over recent years? (3 years)

## Fishing Areas

- In which areas do you fish for Cod? (tick all that apply)

| | |
|---|---|
| North Sea | |
| Skagerrak | |
| Eastern Channel | |
| Kattegat | |
| West of Scotland | |
| Irish Sea | |
| Other? | |
| | |

1. What is the present size of your crew?

2. Has your crew size changed over the past few years? (3 – 5 years)

3. Are you part of any accreditation programme? (tick all that apply)
   - Marine Stewardship
   - Responsible Fishing Scheme
   - Scottish Fisheries Sustainable Accreditation Group
   - Other

4. How does your catch reach the consumer? (tick all that apply)
   - Fish market
   - Direct to supermarket
   - Auction (online / harbourside)
   - Fishmonger
   - Restaurant
   - Other (please list)

5. In what ways has the **current** cod management plan (since 1 January 2009) affected the way you operate your vessel? Has it caused you to:
   - Switch gear? Yes / No
   - Switch target species? Yes / No
   - Invest in new gear? Yes / No
   - Spend more time in port? Yes / No
   - Other changes? (Try to get details of any changes)

6. Have you had any significant expenditure as a result of the **CURRENT** Cod Recovery Plan? If so, how much?

7. Are you more or less profitable than last year?
   - Why?

8. Are you more or less profitable than the year before?

- Why?

9. Have you taken on any other employment since the introduction of the **CURRENT** Cod Recovery Plan?

    - Has your wife/partner or another family member?

10. Have any of your crew taken on any other employment since the introduction of the **CURRENT** Cod Recovery Plan?

    - Has their wife/partner or another family member?

11. In what ways has the Cod recovery plan influenced your business decisions?

Probes: Has the plan caused you to change the way...

- Recruit crew (numbers/skills/type of person)
- Invest in new equipment
- Buy supplies
- Sell your catch
- Think about the future

A. Since 2009

B. Before 2009

12. Since January 2009, how have the different regulations affected you?

- Total Allowable Catch

- Effort

- Which of these has affected the way you fish the MOST?

    - Why is this? (ensure explanation is obtained)

13. If the Cod Recovery Plan were to continue without major changes, how do you think this will affect:
    - Your vessel?

    - Your business?

- You?

14. Do you think that Cod stocks have changed at all in the areas where you fish?
    - Increased
    - Decreased
    - No change
    - Don't know

15. Do you think that the Cod Recovery Plan should apply to the areas that you fish?

    - Yes / No / Don't know

    - Why do you think this?

16. Do you think estimates of stocks are:
    - Under / Over estimated OR accurate?

17. Do you think estimates of discards are:
    - Under / Over estimated OR accurate?

18. Do you think estimates of landings are:
    - Under / Over estimated OR accurate?

19. Have the measures under the Cod Recovery Plan led you to discard Cod?
    - Yes / No

    - If yes – In what way do the measures cause this?

    - Do the measures in the plan cause you to discard other fish?

      Yes / No

    - Do you think you should be able to land whatever you catch?

      Yes / No

    - In your view what would be the best way to reduce discarding of Cod?

20. Is 'Black Fish' (illegal landing) taking place with Cod?
    - Yes / No

- If so, are there any ways it could be reduced?
- Is 'Black Fish' an issue with other species? Would you say this is more or less of a concern than with Cod?
- Why do you think it still occurs? (If relevant)

21. Have you implemented any Cod avoidance measures?
    - Yes / No
    - Type of action
    - Has it been effective? If so, how has it been effective (examples of reduced discard etc)
    - Are you planning any other avoidance actions?
    - Is there anything that could work even better?

22. Do you think Cod stocks are sustainable at the present time?

23. Do you think there are parts of the Cod Management Plan that have HELPED rebuild Cod stocks?
    - Yes / No
    - If yes – which parts, and the effects on Cod
    - Any effects on other species?

24. Do you think there are parts of the Cod Management Plan that have DAMAGED Cod stocks?
    - Yes / No
    - If yes – which parts, and the effects on Cod
    - Any effects on other species?

25. Do you have any suggestions as to how the Cod Management Plan could be improved?
    - To improve Cod stocks

    - To improve the outcomes for fishermen

European Commission

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**Abstract**
A joint ICES / STECF meeting was held in Hamburg 20-24 June 2011, to prepare an impact assessment for Southern hake, Nerphrops and Angler fish and Baltic cod and an Evaluations of existing plans for Kattegat, North Sea, West of Scotland and Irish Sea cod. The meeting involved STECF, ICES scientists dealing with Economy and Biology and included Observers (Commission staff, Managers, Stakeholders). Three separate reports to the STECF were prepared by the EWG-11-07, one on the Impact Assessment of Southern hake, Nerphrops and Angler fish (STECF 11-06) and another on the Impact Assessments for Baltic cod (STECF 11-05) and the third on the Evaluation of Cod in Kattegat, North Sea, West of Scotland and Irish Sea (STECF 11-07). All reports were reviewed by the STECF during its 37th plenary meeting held from 11 to 15 July 2011 in Copenhagen, Denmark. The observations, conclusions and recommendations, in this report represent the outcomes of the Evaluation of Muti-Annual plans for cod in Kattegat, North Sea, Irish Sea and West of Scotland.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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